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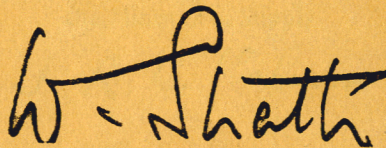
AIR PUBLICATION

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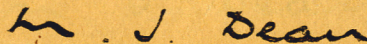
**VOLUME 1
2nd. EDITION**

**RADAR TYPE 7 MkS, 2, 2A, 3 & 3A
AND
RADAR TYPE 79 MkI.**

Prepared by direction of
the Minister of Aviation



Promulgated by Command
of the Air Council



AIR MINISTRY

A.L. 16, Aug. 1960.

NOTE TO READERS

The subject matter of this publication may be affected by Air Ministry Orders, or by "General Orders and Modifications" leaflets in this A.P., in the associated publications listed below, or even in some others. If possible, Amendment Lists are issued to correct this publication accordingly, but it is not always practicable to do so. When an Order, or leaflet contradicts any portion of this publication, the Order, or leaflet is to be taken as the overriding authority.

The inclusion of references to items of equipment does not constitute authority for demanding the items.

Each leaf, except the original issue of preliminaries, bears the date of issue and the number of the Amendment List with which it was issued. New or amended technical matter on new leaves which are inserted when the publication is amended will be indicated by triangles, positioned in the text thus:— ◀ ▶ to show the extent of amended text, and thus:— ▶ ◀ to show where text has been deleted. When a Part, Section, or Chapter is issued in a completely revised form, the triangles will not appear.

- ◀ Radar Type 79 Mk. 1, incorporating I.F.F. Mk. 3G, is now obsolete and references to it in this publication should be ignored. This publication is not being amended because it is being replaced by A.P.2901MA. The latter includes a description of radar Type 79 Mk. 2 in which I.F.F. Mk. 3G is replaced by I.F.F. Mk. 10. ▶



LIST OF ASSOCIATED PUBLICATIONS

◀ Radar Type 13 (Mk. 6 and 7) and 14 (Mk. 7, 8, 9, 10 and 11)	A.P.	
RV500, 501, 502 and static versions	2527B	▶
Information generator for radar stations	2527C	
Test equipment for mobile and static radar stations	2527D	
Information generation and distribution for static radar stations	2527E	
Static radar stations CHEL	2527F	
Static radar stations CEW	2527G	
Static radar stations GC1	2527H	
Radar Type 54 Mk. 2 and 3	2527K	
◀ Radar Type 80 Mk. 1, 2 and 2A	2527Q	
Radar Type 80 Mk. 3	2527QA	▶
Marker unit (video map) Type 30	2527R	
Consoles Type 60 and 60A	2897NA	
◀ Consoles Type 61, 61A and 61B	2897NB	▶
Mobile operations room Type 1 (RV Type 510)	2897Q	
◀ Fixed coil display systems for ground radar stations... ..	2897R	▶
Console Type 65	2897S	
Radar Type 15 Mk. 5	2912K	
◀ Radar Type 7 Mk. 4 and 5	2901MA	
Basic IFF Mk. 10 (ground)	2906K	▶

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**LAYOUT OF A.P.2901M
(2nd Edition)**

RADAR TYPE 7 Mk. 2 and 3

*Heavy type indicates the books being issued under this
A.P. number; when issued they will be listed in A.P.113*

VOLUME 1	General and technical information
Part 1	Leading particulars and general information
Part 2	Technical information
Part 3	Fault diagnosis
Part 4	Testing after installation
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VOLUME 3	Equipment schedules and scales
VOLUME 4	Planned servicing schedules (<i>issued as 90G/2614/2026-2 Vol. 4, Part 5</i>)
VOLUME 5	Basic reconditioning schedules
VOLUME 6	Repair and reconditioning instructions (<i>not issued</i>)

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Chapter I

INTRODUCTION

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Development

1. The radars Type 7, Mk. 2 and 3 form part of the post-war static GCI stations which have been developed under the re-engineering programme from the "final GCI" or AMES Type 7 stations designed during the 1939-45 world war.

Note

In recent years the nomenclature AMES (Air Ministry experimental station) has been replaced by the more specific term "radar."

2. The final GCI stations were a development of a series of mobile and transportable GCI stations which themselves have a post-war equivalent in the radar vehicles RV Type 500, 501, 502, 503, 510, etc. The re-engineering of final GCI involves the complete re-design of the radar portion as far as the AMES Type 7 is concerned and the inclusion of radar Types 13 and 14 (also re-engineered) in the scheme as alternative sources of radar information to the radar Type 7.

3. The equipment in the operations centre has also been re-designed, partly to improve performance and facilities and partly because of the complications introduced by the inclusion of a number of radar heads in the scheme. As far as possible, the radar equipment has been built into racks which are installed in a radar office separate from the operations room, where display consoles only are fitted.

4. Radar Type 7 being a re-engineered version of the AMES Type 7, the installation naturally follows the same basic design as the original

installation, although individual components are, in themselves, entirely new in design.

Application

5. Radar Type 7 is the only metric radar on the GCI station. It provides both PPI and height-finding information and as it operates essentially on the same principle as the original AMES Type 7. When it is in action it must be the master radar head on the station, as pulse-to-pulse aerial lobe switching is carried out by a motor-driven RF switch and its turning gear is a simple Ward Leonard set without any servo control facilities.

6. It provides a sine-wave at pulse recurrence frequency for driving the master trigger units (rack assemblies Type 180, 181, 182 or 183) which feed all radar heads on the station, and also a selsyn output to control the turning gear of all other heads so that they can be made to rotate in synchronism.

7. At the operations centre it provides PPI information which is available for display on all consoles *via* head selector units, and height-finding information for display on a maximum of six height-range consoles (console Type 65).

8. As radar Type 7 is an integral part of GCI stations it is impracticable to describe it as a self-contained equipment. The chapters contained within this volume refer only to such items of radar Type 7 which are installed in one or other of the transmitter wells. For this reason, reference must also be made to the publications relevant to the individual units comprising the complete station a list of which precedes this chapter.

Chapter 2

Overall Technical Description Radar Type 7, Mk. 2

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Introduction

1. Radar 7 Mk. 2 is a development of the aerial and transmitter well portion of the original Air Ministry Experimental Station (AMES) Type 7 (final GCI). The earlier nomenclature was held to embrace all the necessary adjuncts of the station such as operations room equipment, power plant, etc. Radar 7, however, should be regarded as applying only to the aerial assembly and transmitter well equipment.

2. Radar 7 Mk. 2 consists of an aerial system which is continuously rotated about a central pivot by means of a DC motor, controlled by a Ward-Leonard system and the associated radar transmitter and receiver. The aerial equipment is mounted directly above an underground transmitter well made of reinforced concrete. The well houses two transmitters, two receivers and a quantity of auxiliary equipment.

Aerial assembly Frame

3. The aerials, reflector screen and feeders are fixed to a metal framework supported centrally on a tapered roller bearing at the top of a fixed, central, hollow column so that its top is approximately 30 ft. above ground level. The 54 ft. long $\times$ 25 ft. high $\times$ 5 ft. wide frame is rotated by a horizontal chain drive from a 16 h.p. DC motor situated at the foot of the supporting column. The whole assembly has been designed to be capable of continuous rotation at any speed between zero and 6 r.p.m. The speed of rotation is controlled by press buttons in the radar office, the actual speed being indicated by a voltmeter specially calibrated to read from 0-8 r.p.m. and fed by a tachometer-generator coupled to the aerial driving motor. Forming part of the framework and situated above the central column is a small closed cubicle which houses the capacity switch, feeder switching network, rotating coupling unit and slip-ring unit.

Arrays

4. Three separate arrays are mounted on the front vertical face of the frame and are arranged as follows:—

- (1) An 8-bay, 4-stack array of full-wave horizontal dipoles at a mean height of 25 ft. above the ground (top array).
- (2) Two 8-bay, 2-stack arrays of dipoles at heights of $12\frac{1}{2}$ ft. and $7\frac{1}{2}$ ft. (middle and bottom arrays).

5. The elements forming the array are mounted a distance of 18 cm. in front of a reflector screen mounted on one side of the main frame. All the arrays are fed by 320-ohm parallel wire feeders from the capacity switch, these feeders being run inside the main frame.

Capacity switch

6. The capacity switch and the feeder network associated with it enable four different aerial combinations to be used for transmitting and receiving:—

- (1) Top array
- (2) Middle array
- (3) Middle plus bottom arrays
- (4) Bottom array.

The four separate arrangements are fed, in turn, by successive pulses from the transmitter, and the capacity switch is so designed that the array to which the transmitter pulse is fed remains in circuit for a period after the transmitter pulse so as to receive reflected signals and to feed them to the receiver. The capacity switch will therefore determine the maximum range of the station. Alternators inside the capacity switch, mounted on the same shaft as the rotor, generate sine-wave outputs which are used:—

- (1) To drive the master trigger unit which controls the firing of the transmitter and triggers the various display circuits.

- (2) To produce blanking waveforms which enable unwanted signals to be eliminated from any display.

Power to the capacity switch and the outputs from the two alternators are fed between the well and the capacity switch cubicle by slip-rings at the top of the central pillar.

Transmitter well

General

7. All equipment actually at the transmitter site is mounted in a transmitter well underground, in order that spurious reflections, blind arcs, etc., due to buildings near the aerial should be eliminated. Any large buildings on the site should be at least 200 yards away so as to allow relatively unimpeded viewing over the full 360 degrees of azimuth. The well is constructed of reinforced concrete, its internal dimensions being 20 ft. $\times$ 12 ft. 9 in. $\times$ 7 ft. 6 in. or 8 ft. high. The top of the roof is approximately at ground level with the aerial supporting pillar in the centre. An entrance hatch fitted with a balanced cover is provided for normal access to the well; two large traps with removable covers are provided over the top of the transmitters for lowering equipment into the well.

8. The transmitter well contains the following items of radio equipment:—

- (1) Two transmitters Type T.3705 and fan assemblies Type 26.
- (2) Two amplifiers Type A.3694.
- (3) Switch unit Type 405.

In addition to the radio equipment a quantity of other equipment is in the well, including:—

- (1) Control panel (capacity switch) Type 869.
- (2) Phasing unit Type 30.
- (3) Phasing unit Type 4338.
- (4) Power switchboard.

The arrangement of equipment in the transmitter well is shown in fig. 3.

Radar transmitter

9. The radar transmitter T.3705 is entirely self-contained except for the fan assembly 26 which supplies forced air cooling for the two RF valves and which is mounted to one side of the transmitter. The transmitter gives a pulse output at 50 to 450 kW with a pulse width of 3.6 microseconds and a p.r.f. of 250 c/s. The transmitter can be set to operate at any frequency in the band 180 to 220 Mc/s, but operates at a set frequency, because the aerial system is designed for fixed frequency operation. The transmitter includes its own monitor which can display various waveforms, including the output of the receiver (amplifier A.3694). The transmitter is fully automatic in operation and can be switched *on* and *off* from a remote point, which, in this installation, is the radar office.

Radar receiver

10. The radar receiver is the amplifier A.3694 of which two are mounted on the wall. The receiver in use receives the signal from all arrays in turn and gives an IF output at 45 Mc/s which is fed over coaxial cable to the operations building where

detection, amplification and display takes place. The output of the receiver is also fed to the transmitter monitor which incorporates an IF amplifier, detector, and other circuits for this purpose.

Switch unit Type 405

11. This unit, which is mounted on the ceiling of the transmitter well, enables the transmitter and receiver to be operated from the common aerial system. The unit utilizes open-wire lines and adjustable open spark-gaps in a conventional T-R switching circuit. It is connected in the well feeder system between the transverse feeder and the main vertical feeder.

Control panel (capacity switch) Type 869, phasing unit Type 30 and phasing unit 4338

12. The function of the capacity switch has already been described in para. 6. In the well there are three units associated with it:—

(1) Control panel (capacity switch) Type 869 on which is mounted the ON/OFF switch for the 3-phase supply to the capacity switch motor, the rheostats which control the field currents of the two alternators built into the capacity switch, and the change-over switch for the control circuits and the synchronizing supplies for the two transmitters.

(2) Phasing unit Type 30 on which is mounted a phasing potentiometer which controls the phase of the outputs from the capacity switch alternators to the radar office (see A.P.2527E).

(3) Phasing unit 4338 on which is mounted a phasing potentiometer network which is used for phasing the blanking sine waves which are fed to the transmitter monitor.

Transmitter change-over

13. Two transmitters are provided in the well. Either can be used; the procedure for change-over from one to the other is as follows:—

(1) Switch off transmitter in use and change over supplies to the two transmitters at the well distribution board.

(2) Switch over the control and driving circuits at the capacity switch control panel.

(3) Change over the feeder shorting bar from one side of the aerial feeder to the other. This bar should be a distance of $\lambda/4$ from the feeder junction. The correct position on the feeder is clearly marked.

(4) Switch on second transmitter.

Test equipment

14. The equipment supplied on the station specially for use with the Type 7 is as follows:—

(1) Test kit 29A—for measuring standing wave ratios on feeders.

(2) Test set 404 (10S/16159) a CW oscillator for use when measuring standing-wave ratios or checking polar diagrams.

(3) Signal generator (noise) 1 (10S/16159) a source of RF noise for receiver noise factor measurements.

(4) Dummy load 28 (modulator) (10S/16154) a dummy load for testing the modulator without the RF oscillator.

(5) Dummy load 29 (transmitter) (10S/16155) a dummy load for testing the complete transmitter. Item (3) is fixed to the wall of the transmitter well.

Power supplies

15. Power supplies for the transmitter well are obtained from the 400/230V 50 c/s 3-phase supply feeding the complete station, a 230V single-phase supply being fed to the well for operating all equipment.

16. A DC supply controllable between 0 and 230V is obtained from the output of a Ward-Leonard set in the station machine room on the site for armature supply for the motor rotating the aerial assembly. A 230V DC supply is also obtained from the exciter of the Ward-Leonard set for the field winding of this motor. Variation in the speed of rotating of the aerial assembly is obtained by varying the output voltage of the Ward-Leonard set. The controls for doing this are in the radar office, on the control unit (training) Type 618.

17. The 230V DC output from the exciter of the Ward-Leonard set is also brought into the well on other circuits for the supply of field current to the two alternators in the capacity switch via the control panel (capacity switch) Type 869.

18. The 230V DC output from the exciter is also used to drive the alternator unit Type 3A. This alternator is in the machine room and supplies a 3-phase supply at a frequency of between 16 and 22 c/s for driving the capacity switch. The frequency of this supply is controlled by a rheostat on the panel, meter (p.r.f.), Type 871 in the radar office, while the voltage of the 3-phase supply is controlled by a control on the DC control panel in the machine room.

- KEY TO FIG. 1
- 1 CAPACITY SWITCH CUBICLE
 - 2 TOP ARRAY
 - 3 SIGNAL GENERATOR (NOISE) TYPE 1
 - 4 MIDDLE ARRAY
 - 5 BOTTOM ARRAY
 - 6 EQUIPMENT HATCH
 - 7 AERIAL TACHOMETER-GENERATOR
 - 8 } RECEIVER (AMPLIFIER TYPE A.3694)
 - 9 }
 - 10 TRANSMITTER T.3705
 - 11 WELL FEEDER NETWORK
 - 12 AERIAL FRAME DRIVING MOTOR
 - 13 SWITCH UNIT TYPE 405 (ON WELL ROOF)
 - 14 FAN ASSEMBLY TYPE 26
 - 15 MAIN VERTICAL FEEDER
 - 16 COLUMN JUNCTION BOX
 - 17 CONTROL PANEL (CAPACITY SWITCH) TYPE 869
 - 18 PHASING UNIT ($\frac{1}{2}$ PRF) TYPE 100
 - 19 PHASING UNIT 4338
 - 20 FAN ASSEMBLY TYPE 26
 - 21 ENTRANCE HATCH
 - 22 TRANSMITTER TYPE T.3705
 - 23 TRANSMITTER COMPARTMENT SWITCHBOARD
 - 24 EQUIPMENT HATCH
 - 25 TERMINATION BOX
 - 26 REST SPACE
 - 27 EQUIPMENT HATCH
 - 28 RACK ASSEMBLY TYPE 318 OR 318A
 - 29 RACK ASSEMBLY (CONTROL) TYPE 330
 - 30 RACK ASSEMBLY TYPE 183 OR 183A
 - 31 ALTERNATOR UNIT TYPE 3A (FOR CAPACITY SWITCH)
 - 32 CONTACTOR PANEL FOR WARD-LEONARD SET
 - 33 FAN ASSEMBLY TYPE 26
 - 34 WARD-LEONARD GENERATOR SET, TYPE 81
 - 35 DC CONTROL PANEL
 - 36 CHEMICAL-CLOSET
 - 37 ENTRANCE HATCH
 - 38 CABLE JUNCTION BOX
 - 39 SAFETY SWITCH
 - 40 MAIN THREE-PHASE SWITCHBOARD
 - 41 WARD-LEONARD SPEED CONTROL RHEOSTAT

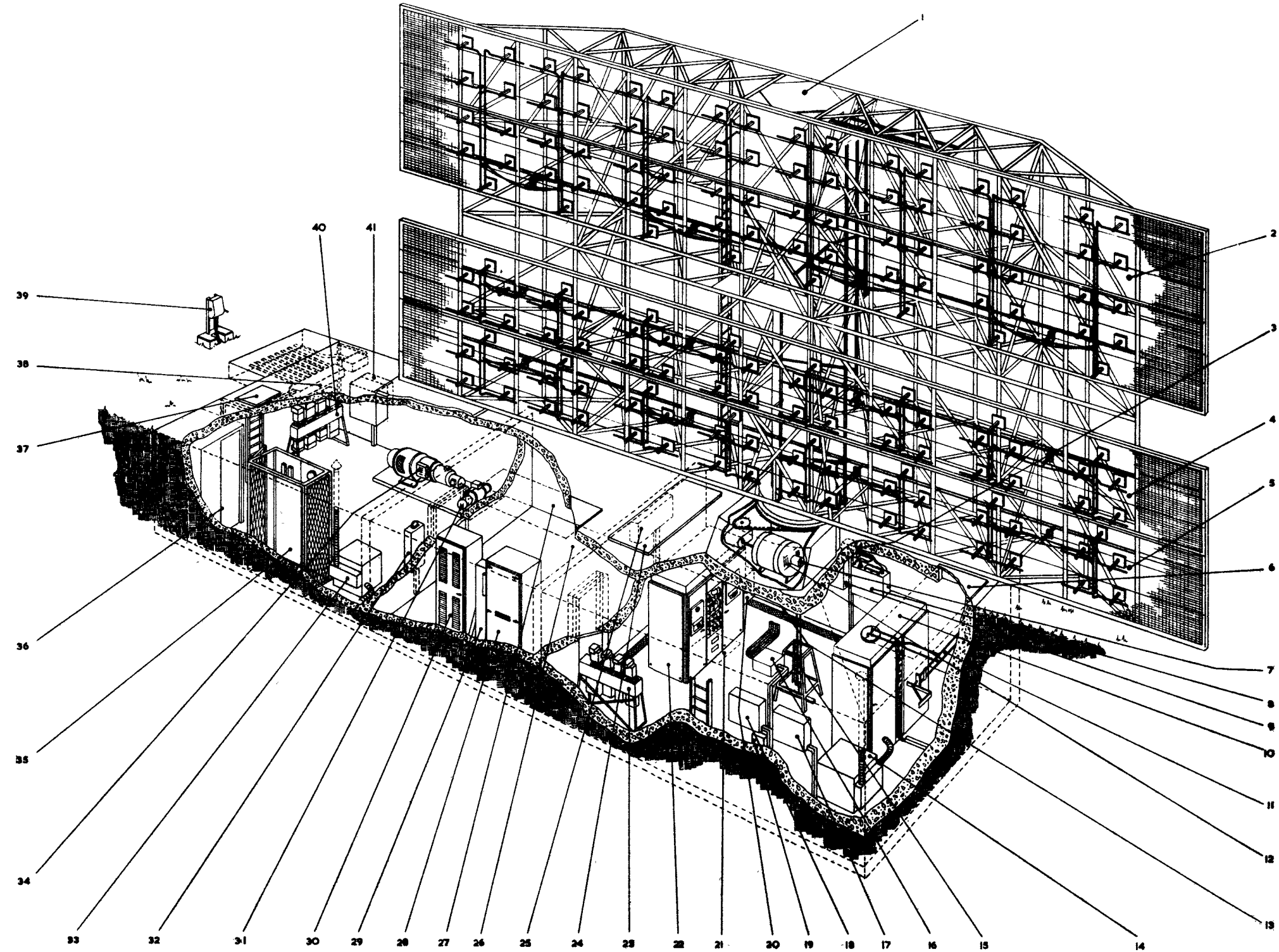
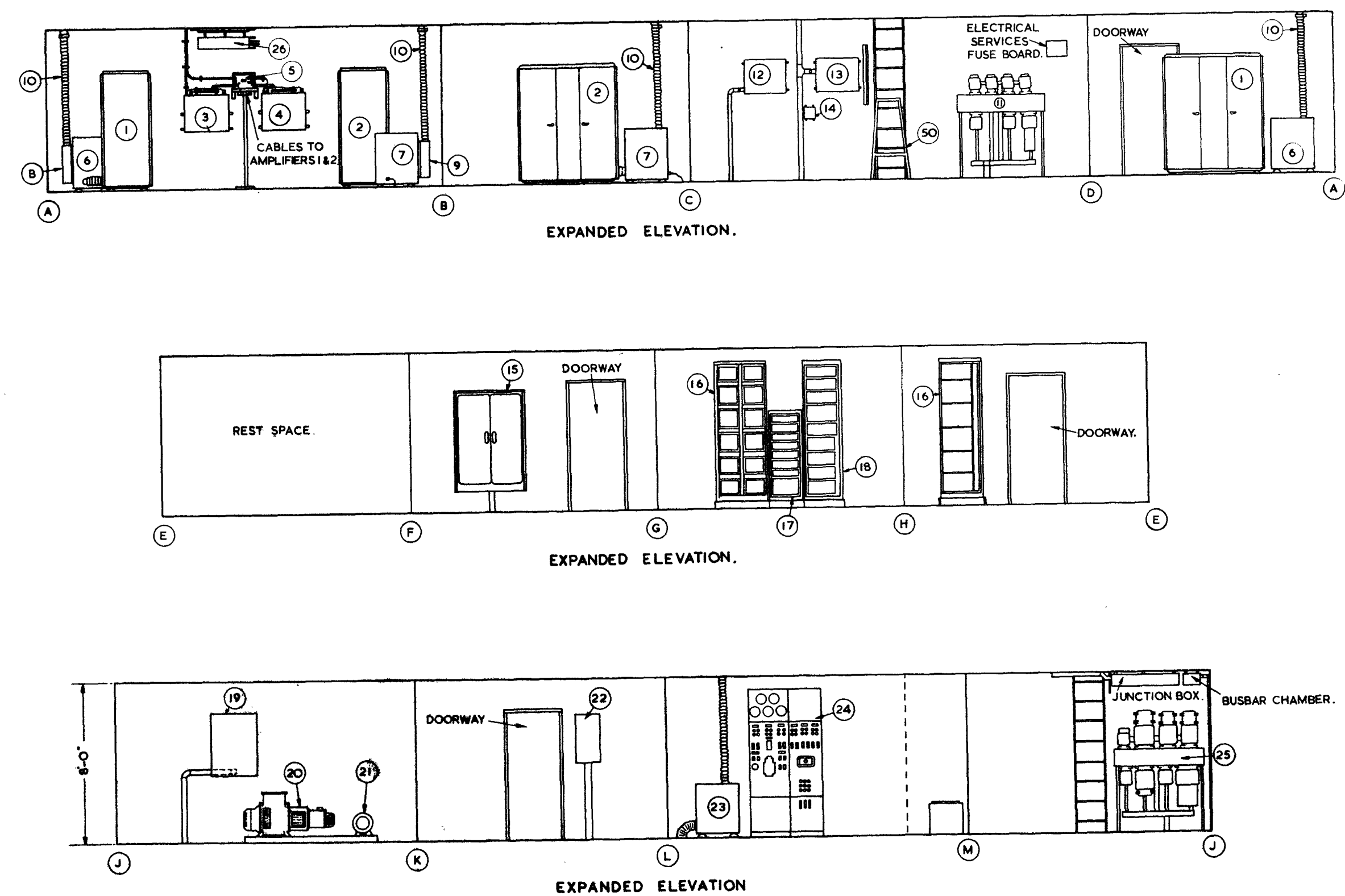
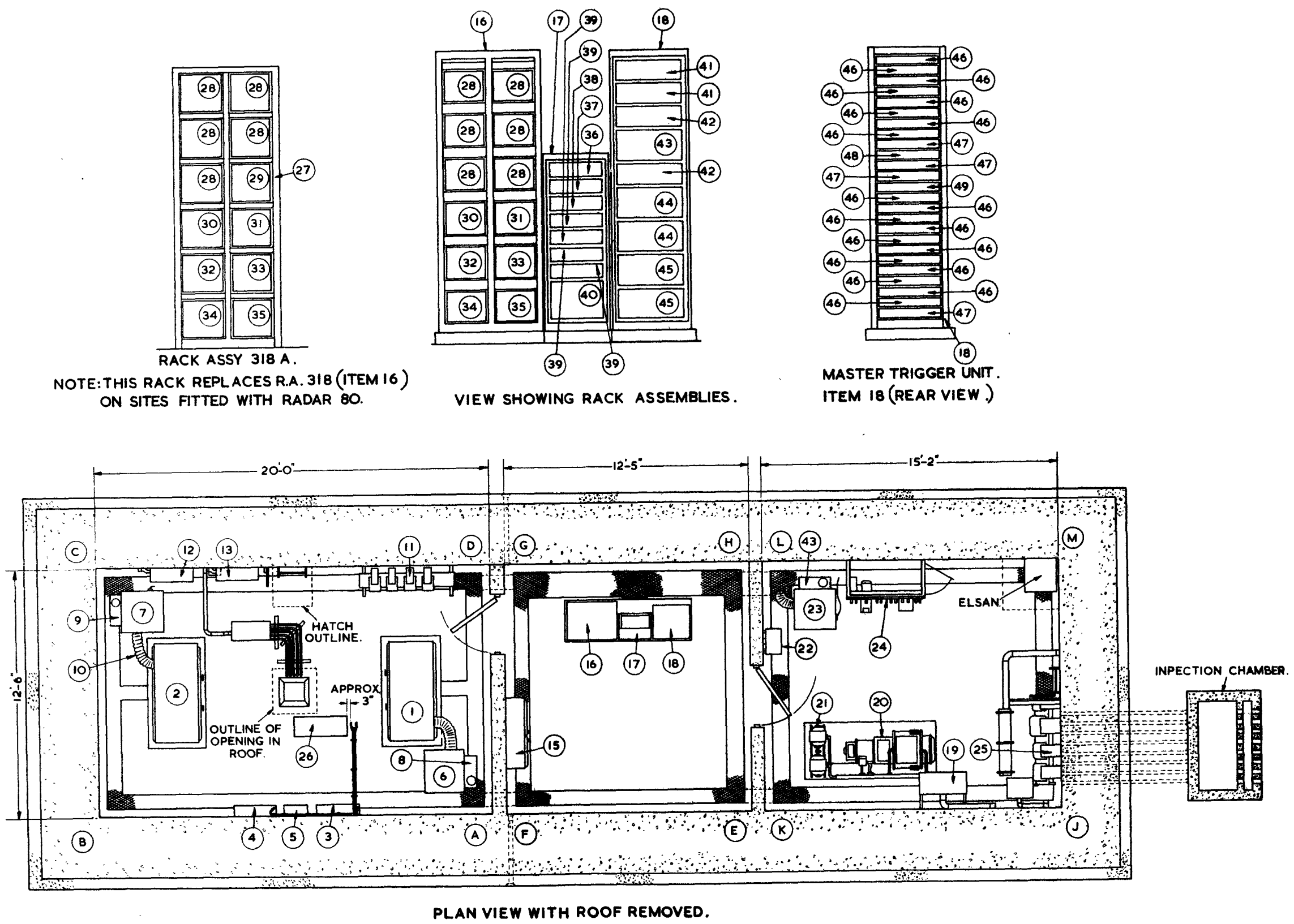


Fig. 1.

Radar 7 Mk.3. General View

Fig. 1

(A.L.2, Nov.55)



- KEY TO FIG 4.
- 1 TRANSMITTER T.3705
 - 2 TRANSMITTER T.3705
 - 3 AMPLIFIER A.3694
 - 4 AMPLIFIER A.3694
 - 5 SIGNAL GENERATOR (NOISE) I
 - 6 FAN ASSEMBLY 26
 - 7 FAN ASSEMBLY 26
 - 8 FAN COWLING
 - 9 FAN COWLING
 - 10 FLEXIBLE AIR TRUNKING
 - 11 TRANSMITTER WELL SWITCHBOARD (SINGLE-PHASE)
 - 12 CONTROL PANEL (CAPACITY SWITCH) 869
 - 13 PHASING UNIT (1 PRF) 100
 - 14 PHASING UNIT 4338
 - 15 GPO TERMINATION BOARD AND CABINET
 - 16 RACK ASSEMBLY 318
 - 17 RACK ASSEMBLY (CONTROL) 330
 - 18 RACK ASSEMBLY 183
 - 19 RHEOSTAT AND TERMINAL BOARD ASSEMBLY
 - 20 MOTOR GENERATOR 81
 - 21 ALTERNATOR UNIT 3A (FOR CAPACITY SWITCH)
 - 22 MOTOR GENERATOR STARTER PANEL
 - 23 FAN ASSEMBLY 26 (FOR RACK COOLING)
 - 24 DC CONTROL PANEL
 - 25 MAIN AC SWITCHBOARD THREE-PHASE
 - 26 SWITCH UNIT (T & R) 405
 - 27 RACK ASSEMBLY 318A
 - 28 BLANK PANEL
 - 29 AMPLIFYING UNIT (PULSE) 4279
 - 30 TRANSFORMER UNIT 175
 - 31 RECTIFIER UNIT 17
 - 32 AMPLIFYING UNIT A.3719
 - 33 CONTROL UNIT 600
 - 34 AMPLIFIER (IFF) A.3677
 - 35 AMPLIFIER (SERVO) 297
 - 36 PANEL METER (PRF) 871
 - 37 CONTROL UNIT (TRAINING) 618
 - 38 CONTROL UNIT 620
 - 39 BLANK PANEL
 - 40 BLANK PANEL
 - 41 POWER UNIT (NEGATIVE) 890
 - 42 WAVEFORM GENERATOR 79
 - 43 SWITCH UNIT 413
 - 44 BLANK PANEL
 - 45 POWER UNIT (POSITIVE) 889
 - 46 BLANK PANEL
 - 47 DELAY UNIT 31
 - 48 PANEL METER 650
 - 49 TRANSPORTER UNIT 4278
 - 50 FEEDER PROTECTING FRAMEWORK

Fig.4

Layout of Equipment in Well.

Fig.4.

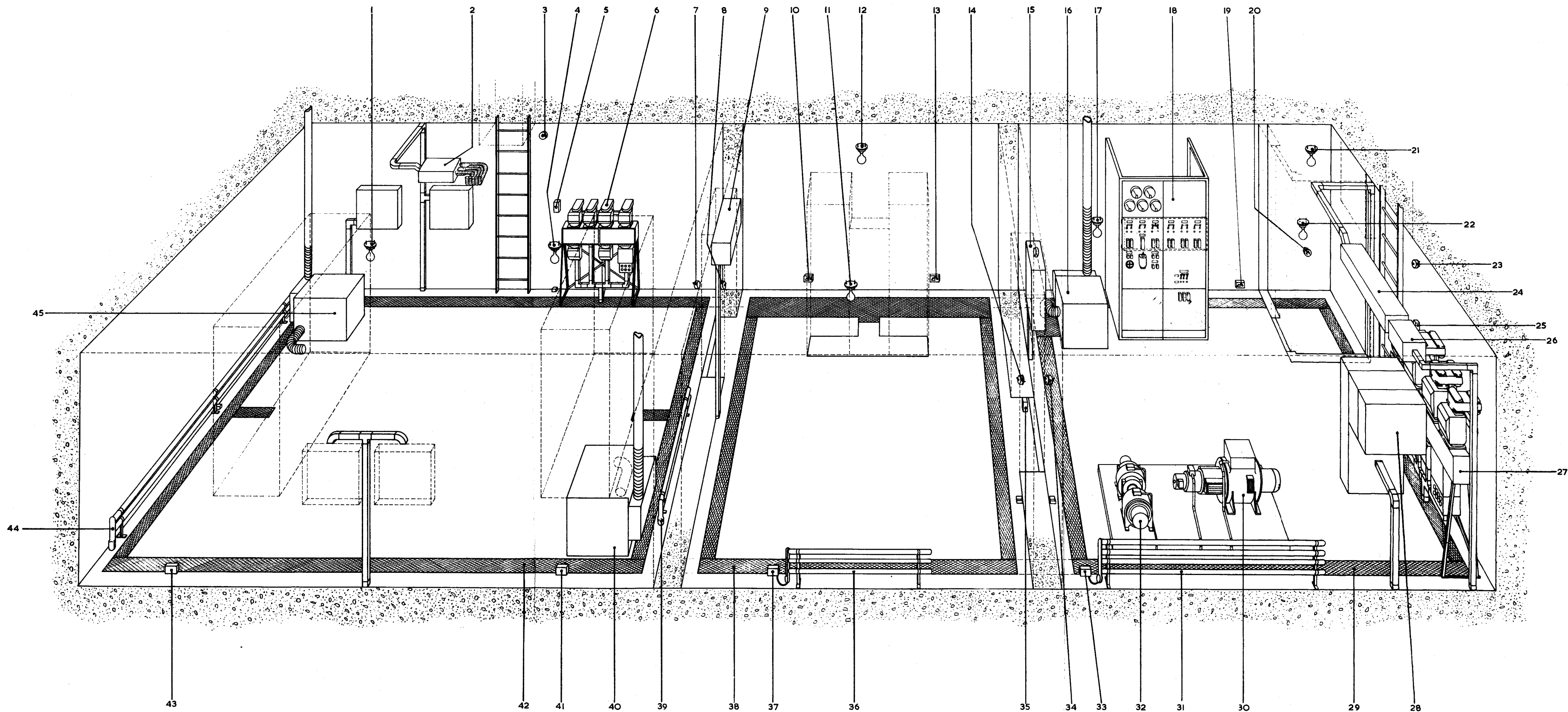


Fig. II

Radar Type 7 Mk.3—layout of electrical equipment in well

Fig. II.

(AL 12, Jan 1957)

Chapter 3

Overall Technical Description Radar Type 7, Mk. 3

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Introduction

1. Radar 7 Mk. 3 is basically the same as Radar 7 Mk. 2 described in Chapter 2 of this Section, but owing to a different operational requirement, the equipment is considerably more complicated.

2. In this application the transmitter well is at a distance, possibly several miles, from the operations centre. Consequently the well has to contain more equipment as the station is virtually self-contained as apart from display consoles which are in the operations rooms and to which the signals are fed over a coaxial cable. The station also incorporates IFF equipment mounted in a separate cabin near the aerial site.

3. Radar 7 Mk. 3 consists of an aerial system which is continuously rotated about a central pivot by means of a DC motor controlled by the Ward-Leonard system, and the associated radar transmitter, receiver and ancillaries. The aerial equipment is mounted directly above an underground transmitter well made of reinforced concrete. The well is divided into three compartments which house:—

(1) The transmitters, receivers and auxiliary equipment.

(2) The rack assemblies housing control equipment, master trigger unit and amplifiers, etc.

(3) The Ward-Leonard control gear, an alternator and switchboards.

A general view of the system is shown in Fig. 1 and the layout of equipment in the well in fig. 4. These diagrams are at the end of this chapter.

Aerial assembly

Frame

4. The aerials, reflector screen and feeders are fixed to a metal framework supported centrally on a tapered roller bearing at the top of a fixed, hollow, cylindrical column so that its top is approximately 30 ft. above ground level. The 54 ft. × 25 ft. × 5 ft. frame is rotated by a horizontal chain drive from a 16 h.p. DC motor situated at the foot of the supporting column. The whole assembly is capable of continuous rotation at any speed between 0 and 6 r.p.m. The speed of rotation is controlled by press-buttons in the transmitter well, the actual speed being indicated by a voltmeter specially calibrated to read from 0 to 8 r.p.m. and fed by a tachometer-generator coupled to the aerial driving motor. Forming part of the framework and situated above the central column is a small closed cubicle which houses the capacity switch, feeder switching network, rotating coupling unit and slip-ring unit.

Arrays

5. Three separate arrays are mounted on the front vertical face of the frame, one above the other, arranged as follows:—

(1) An 8-bay, 4-stack array of full-wave horizontal dipoles at a mean height of 25 ft. above the ground (**top** array).

(2) Two 8-bay, 2-stack arrays of dipoles at heights of 12½ ft. and 7½ ft. (**middle** and **bottom** arrays).

6. The elements forming the arrays are mounted a distance of 18 cm. in front of a reflector screen

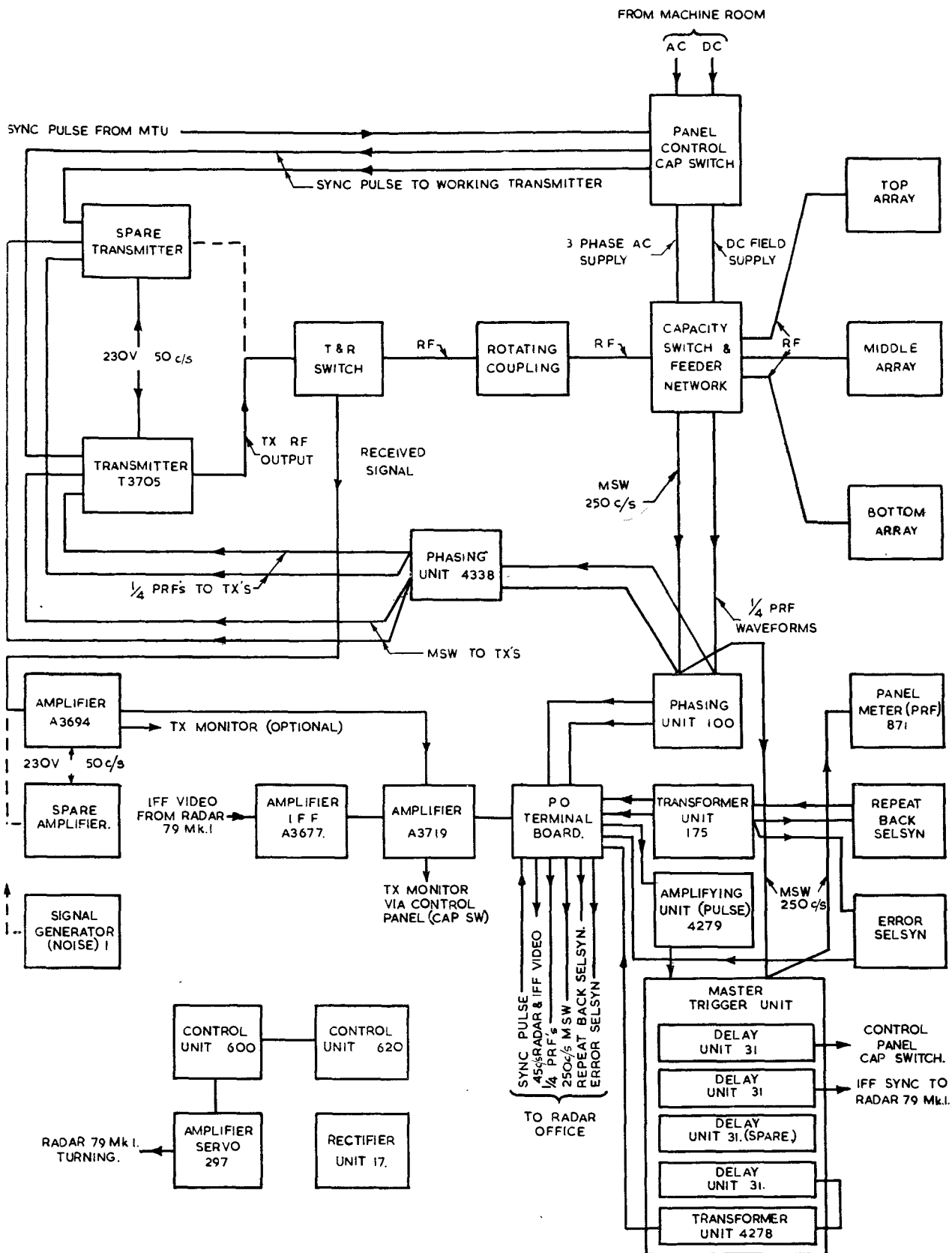


Fig. 2. Radar Type 7 Mk. 3, block diagram when used with radar Type 80

carried at the back of the main frame. All the arrays are fed by 320-ohm parallel wire feeders from the capacity switch, these feeders being run inside the main frame.

Capacity switch (switch unit 506)

7. The capacity switch and the feeder network associated with it enable four different aerials combinations to be used for transmitting and receiving. These are:—

- (1) Top array.
- (2) Middle array.
- (3) Middle plus bottom arrays.
- (4) Bottom array.

The four separate arrangements are fed, in turn, by successive pulses from the transmitter, and the capacity switch is so designed that the array to which the transmitter pulse is fed, remains in circuit for a period after the transmitter pulse so as to receive reflected signals and to feed them to the receiver. The capacity switch will therefore determine the maximum range of the station. Alternators inside the capacity switch, mounted on the same shaft as the switch rotor, generate sine-wave outputs which are used:—

- (1) To control the firing of the transmitter and triggering of the various display circuits.
- (2) To produce blanking waveforms which enable unwanted signals to be eliminated from any display.

Power to the capacity switch and the outputs from the two alternators are fed from the well to the capacity switch cubicle by slip-rings at the top of the central pillar.

Transmitter well

General

8. All equipment actually at the transmitter site is mounted underground in a transmitter well so that spurious reflections, blind arcs, and other faults due to buildings near the aerial are eliminated. Any large buildings on the site should be at least 200 yards distant so as to allow relatively unimpeded viewing over the full 360 degrees of azimuth. The well is constructed of reinforced concrete, its internal dimensions being 50 ft. × 12 ft. 6 in. × 8 ft. The well is divided into three compartments which are 20 ft., 12 ft. 5 in., and 15 ft. 2 in. long. The top of the well roof is approximately at ground level with the aerial supporting pillar in the centre of that portion of the roof over the transmitter compartment. Entrance hatches are provided to the transmitter compartment and machine rooms; doors in the dividing walls join all three compartments. Hatches are provided in the roof of the well so that equipment can be lowered into the compartment. Two hatches are provided for this purpose in the transmitter compartment, while one is provided in each of the other two compartments. All these traps are provided with removable covers.

9. The equipment inside the transmitter well consists of:—

(1) Transmitter compartment				
Transmitter T.3705	...	...	...	2
Fan assembly 26	...	...	...	2
Switch unit 405	...	...	...	1
Amplifier A.3694	...	...	...	2
Control panel (capacity switch) 869	...	...	...	1
Phasing unit ($\frac{1}{2}$ PRF) 100	...	...	...	1
Phasing unit 4338	...	...	...	1
Power switchboard	...	...	...	1

(2) Apparatus room				
Rack assembly 183 including:—				
Waveform generator 79	...	...	...	2
Switch unit 413	...	...	...	1
Power unit, positive 889	...	...	...	2
Power unit, negative 890	...	...	...	2
Panel, meter 650	...	...	...	1
Delay unit 31	...	...	...	4
Transformer unit 4278	...	...	...	1

or

Rack assembly 183A including:—				
Waveform generator 79A	...	...	...	2
Switch unit 413A	...	...	...	1
Power unit, positive 889	...	...	...	2
Power unit, negative 890	...	...	...	2
Panel meter 650	...	...	...	1
Delay unit 31	...	...	...	4
Transformer unit 4278	...	...	...	1

or

Rack assembly 318 including:—				
Rectifier unit 17	...	...	...	1
Amplifier, servo, 297	...	...	...	1
Control unit 600	...	...	...	1
Amplifier (IFF) 3677	...	...	...	1
Amplifier 3719	...	...	...	1
Transformer unit (selsyn) 175	...	...	...	1
Amplifying unit (pulse) 4279	...	...	...	1

Rack assembly (control) 330 including:—				
Panel meter (p.r.f.) 871	...	...	...	1
Control unit (training) 618	...	...	...	1
Control unit 620	...	...	...	1

- (3) Machine room**
- Ward-Leonard generator set (motor generator 81).
- Capacity switch alternator set (alternator unit 3A).
- DC switchboard and motor starter.
- Fan assembly 26.
- 3-phase switchboard.

Transmitter compartment

Transmitter T.3705

10. The radar transmitter T.3705 is entirely self-contained except for the fan assembly 26, which is mounted to one side of the transmitter and which supplies forced air cooling for the two RF valves. The transmitter gives a pulse output

(A.L.I I, Dec. 56)

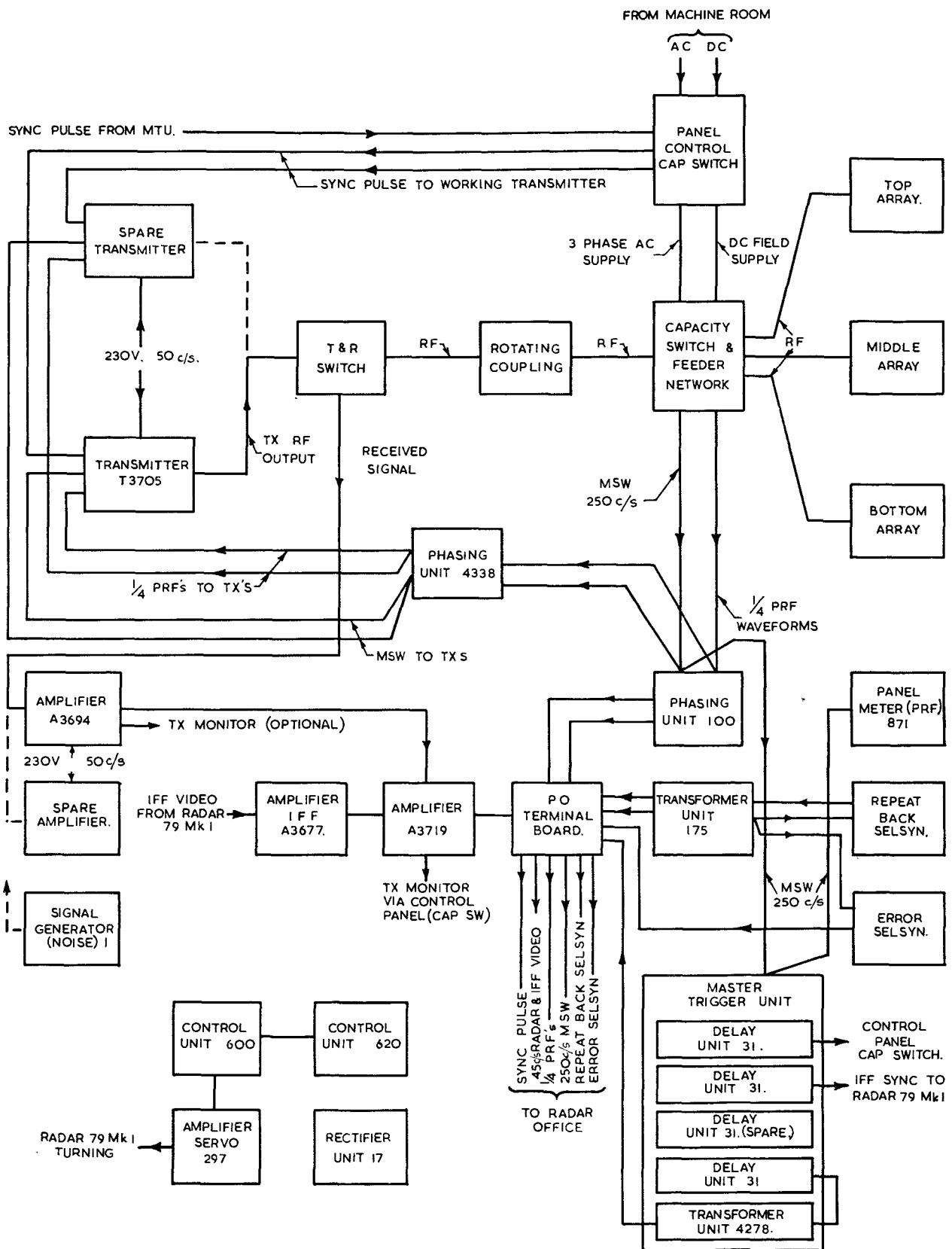


Fig. 3. Radar Type 7 Mk. 3—block diagram

at 50–450 kW with a pulse width of 3.6 micro-seconds and a p.r.f. of 250 c/s. The transmitter can be set to operate at any frequency in the band 180–220 Mc/s but operates at a set frequency, because the aerial system is designed for fixed frequency operation. The transmitter incorporates its own monitor which can display various signals, including the output of the receiver (amplifier A.3694). The transmitter is fully automatic in operation and can be switched on and off from a remote point which, in this installation, is the apparatus room.

Radar receiver

11. The radar receiver is amplifier A.3694, two of which are mounted on the wall. The receiver in use receives the signal from all arrays and gives an IF output at 45 Mc/s which is fed to the amplifier A.3719 in the apparatus room. This gives a 45 Mc/s output for feeding to the operations centre. The output of the receiver is also fed to the transmitter monitor, incorporating an IF amplifier, detector, etc.

Switch unit 405

12. This unit, which is mounted on the ceiling of the transmitter well, enables the transmitter and receiver to be operated from the common aerial. The unit utilizes open-wire lines and adjustable open spark-gaps in a conventional T–R switching circuit. It is connected in the well feeder system between the transverse feeder and the main vertical feeder.

Control panel (capacity switch) 869, phasing unit 100 and phasing unit 4338

13. The function of the capacity switch has already been described in para. 7. In the transmitter compartment there are three units associated with it. These are:—

(1) Control panel (capacity switch) 869, on which is mounted the (a) *on/off* switch for the three-phase supply to the capacity switch motor, (b) the rheostats which control the field currents of the two alternators built into the capacity switch, (c) the change-over switch for the control circuit and synchronizing supplies for the two transmitters, and the monitor output from Amplifier A.3719.

(2) Phasing unit 100, on which are mounted (a) a phasing potentiometer which controls the phase of the $\frac{1}{2}$ p.r.f. outputs from the capacity switch alternators and (b) transformers for feeding the GPO pairs.

(3) Phasing unit 4338, on which is mounted a phasing potentiometer network used for phasing the blanking sinewaves which are fed to the transmitter monitor.

Transmitter change-over

14. Two transmitters are provided in the well. Either can be used; the procedure for change-over from one to the other being as follows:—

(1) Switch off the transmitter in use and change over supplies to the transmitters at the well distribution board.

- (2) Switch over the control and driving circuits to the transmitters and the IF monitoring at the capacity switch control panel.
- (3) Change over the feeder shorting-bar from one side of the aerial feeder to the other. This bar should be a distance of $\lambda/4$ away from the feeder junction. The correct position on the feeder is clearly marked.
- (4) Switch on the second transmitter.

Test equipment

15. The equipment supplied on the station specially for the use with the Radar 7 Mk. 3 is as follows:—

(1) Test kit 29A—for measuring standing wave ratios on feeders.

(2) Test set 404 (10S/16159)—a CW oscillator for use when measuring standing-wave ratios or checking polar diagrams.

(3) Signal generator (noise) (10S/16159)—a source of RF noise for receiver noise factor measurements.

(4) Dummy load 28 (modulator) (10S/16154)—for testing the modulator without the RF oscillator.

(5) Dummy load 29 (transmitter) (10S/16155)—for testing the complete transmitter.

Item (3) is fixed to the wall of the transmitter well.

Apparatus compartment

Rack Assembly 183

16. This rack accepts the master sine-wave at pulse recurrence frequency (250) from one of the two alternators on the capacity switch and provides synchronizing pulses with delays variable up to 120 micro-seconds for driving the transmitter T.3705, the IFF equipment, for feeding to the radar office and for test and setting-up purposes. The outputs from the rack are 20V, 4 micro-seconds positive-going pulses into 70-ohm loads. Spare units are provided in the case of the waveform generators, the power unit 889 and the power unit 890 and the change-over from working to spare unit is automatic (A.P.2527E).

17. The function of the individual units on the rack are, briefly as follows:—

(1) **Switch unit 413**—This is the distribution panel for the mains supplies to the racks. Switches on it control to all units. It also contains circuits for selecting the type of synchronizing input.

(2) **Power unit (positive) 889**—This power unit supplies a regulated power supply of positive 300V, 500mA and supplies all positive voltages to the delay units and waveform generators.

(3) **Power unit (negative) 890**—This power unit supplies a regulated power supply of negative 200V, 120mA for bias supplies for the delay units and waveform generators.

(4) **Waveform generator 79**—This unit accepts the master sine-wave from the capacity switch and, from it, produces a pulse train of pulses of 150 μ S duration. These are used to drive a sawtooth generator positive-going 150 μ S duration. The unit produces waveforms at a repetition frequency of

250 and 500 c/s. The sawtooth waveform is fed to the delay units 31.

(5) **Panel, meter 650**—This incorporates a meter and jack plug and is used for testing delay units.

(6) **Delay unit 31**—This unit takes the sawtooth output from the waveform generator and from it produces a positive-going pulse of 4 μ S duration delayed by a pre-determined amount from the start of the sawtooth. This delay is determined by the setting of fine and coarse controls on the unit. There are four delay units in the rack. They are used as follows:—

- (a) Trigger for working transmitter T.3705.
- (b) Trigger for IFF equipment (radar 79 Mk. 1).
- (c) Trigger to radar office MTU via transformer unit 4278.
- (d) Spare and test.

(7) **Transformer unit 4278**—This unit takes the pulse output from one delay unit 31, and transforms it from an unbalanced to a balanced output for feeding over a balanced line to the master trigger unit in the operations centre.

Rack assembly 183A

18. This rack replaces the rack assembly 183 when there is also a radar 80 on the station. It accepts a pulse at a p.r.f. of 250 c/s from the trigger unit, in the main radar office, via a pulse link and provides synchronizing pulses with delays up to 170 μ S for driving the transmitter T.3705, the IFF equipment feeding to the radar office and for test and setting-up purposes. The outputs from the rack are 20V, 4 μ S positive-going pulses into 70-ohm loads. Spare units are provided in the case of the waveform generator, the power unit 889 and the power unit 890, and the change-over from working to spare unit is automatic (A.P.2527E). It should be noted that the radar 80 trigger unit is itself driven from the master sine-wave output from the Type 7 capacity switch and the timing of the pulse fed back to the Type 7 is such that the transmitter fires when the capacity switch is in the correct position.

19. The functions of the individual units in the rack are, briefly, as follows:—

(1) **Switch unit 413A**—This is the distribution panel for the mains supplies to the racks. Switches on it control power to all units.

(2) **Power unit (positive) 889**—This power unit supplies a regulated power supply of positive 300V, 500mA and supplies all positive voltages to the delay units and waveform generators.

(3) **Power unit (negative) 890**—This power unit supplies a regulated power supply of negative 200V, 120mA for bias supplies for the delay units and waveform generators.

(4) **Waveform generator 79A**—This unit accepts the 250 c/s pulse from the amplifying unit (pulse) 4279 and from it produces a pulse train of pulses of 150 μ S duration and these are used to drive a sawtooth generator which produces a positive-going sawtooth of duration 150 microseconds. The unit produces waveforms at a repetition frequency of 250 c/s. The sawtooth waveform is fed to the delay units.

(5) **Panel meter 650**—This incorporates a meter

and jack plug and is used for testing delay units.

(6) **Delay unit 31**—This unit takes the sawtooth output from the waveform generator and from it produces a positive-going pulse of 4 μ S duration delayed by a pre-determined amount on the start of the sawtooth. This delay is determined by the setting fine and coarse controls on the unit. There are four delay units in the rack. They are used as follows:—

- (a) Trigger for working transmitter T.3705.
- (b) Trigger for IFF equipment (79 Mk. 1).
- (c) Trigger to radar office MTU via transformer unit 4278.
- (d) Spare and test.

(7) **Transformer unit 4278**—This unit takes the pulse output from one delay unit 31, and transforms it from an unbalanced to a balanced output for feeding over a balanced line to the master trigger unit in the operations centre.

Rack assembly 318

20. This rack has three separate functions:—

(1) The servo control of the cabin which houses the G-band IFF equipment (*para.* 32).

(2) Amplification of the 45 Mc/s IF output of the radar receiver, and combination of this with the video output of the IFF equipment for feeding over coaxial cable to the operations centre.

(3) Stepping-up of the output voltage of the repeat-back selsyn on the aerial assembly so that the voltage drop in the lines which carry the selsyn signals to the operations room is reduced to a minimum.

21. The functions of the individual units on the rack are:—

(1) **Rectifier unit 17**—This unit supplies a 50V DC supply for the operation of the relays in the amplifier, servo, 297 and the control unit 600, and the contactor in the fan assembly 26 in the machine room.

(2) **Amplifier servo 297** } These two units provide the servo control
(3) **Control unit 600** } of the radar 79 Mk. 1.

(4) **Amplifier A.3719**—This unit accepts the 45 Mc/s output of the radar receiver and amplifies it to a suitable level for feeding down the coaxial line to the operations centre for display. It also incorporates a combining circuit for combining the IFF video with the 45 Mc/s radar output so that both can be fed over the same cable.

(5) **Amplifier (IFF) A.3677**—This unit accepts the G-band IFF signals from Radar 79 Mk. 1 and amplifies and limits it before feeding it to the amplifier A.3719 for transmission to the operations centre. This unit consists of three identical video amplifiers with a built-in power supply. Only one amplifier is used.

(6) **Transformer unit (selsyn) 175**—This unit steps up the output of the repeat-back selsyn on the aerial assembly to 400V for transmission to the operations centre radar office and transforms the selsyn supply voltage fed from the radar office at 700V back to 230V.

Rack assembly 318A

22. This rack replaces the rack assembly 318 when there is also a radar 80 on the station. It has four separate functions.

(1) The servo control of the cabin which houses the G-band IFF equipment (*para.* 32).

(2) Amplification of the 45 Mc/s IF output of the radar receiver, and combination of this with the video output of the IFF equipment for feeding over coaxial cable to the operations centre.

(3) Stepping-up of the output of the repeat-back selsyn on the aerial assembly so that the voltage drop in the lines which carry the selsyn signals to the operations room is reduced to a minimum.

(4) Amplification and shaping of the trigger pulse from the radar office before feeding to the master trigger unit.

23. The functions of the individual units in the rack are:—

(1) **Rectifier unit 17**—This unit supplies a 50V DC supply for the operation of the relays in the amplifier, servo 297 and the control unit 600, and the contactor on the fan assembly 26 in the machine room.

(2) **Amplifier servo 297** } These two units provide the servo control
Control unit 600 } of radar 79 Mk. 1.

(4) **Amplifier A.3719**—This unit accepts the 45 Mc/s output of the radar receiver and amplifies it to a suitable level for feeding down the coaxial line to the operations centre for display. It also incorporates a combining circuit for combining the IFF video with the 45 Mc/s radar output so that both can be fed over the same cable.

(5) **Amplifier (IFF) A.3677**—This unit accepts the G-band IFF signals from radar 79 Mk. 1 and amplifies and limits it before feeding it to the amplifier A.3719 for transmission to the operations centre. This unit consists of three identical video amplifiers with a built-in power supply. Only one amplifier is used.

(6) **Transformer unit (selsyn) 175**—This unit steps up the output of the repeat-back selsyn on the aerial assembly to the operations centre radar office and transform the selsyn supply voltage fed from the radar office at 700V back to 230V.

(7) **Amplifying unit (pulse) 4279**—This unit accepts the synchronizing pulse fed from the radar 80 trigger unit in the radar office, shapes it, amplifies it and feeds it to the rack assembly 183A.

Rack assembly (control) 330

24. This rack provides control facilities for the transmitter well and IFF cabin.

The functions of the individual units are as follows:—

(1) **Panel, meter (p.r.f.) 871**—This unit consists of a frequency-sensitive network feeding a meter. The network is fed from the master sine-wave output from the capacity switch. A control on the front panel operates a variable rheostat on the rear of the unit which controls the field of the DC motor driving the capacity switch alternator. Thus the speed of the capacity switch is adjusted until the master sine-wave (and hence the transmitter p.r.f.) is 250 c/s, the meter reading equivalent to this being given on a label on the front panel.

(2) **Control unit (training) 618**—This unit houses the START and STOP buttons for the Ward-Leonard set (and hence the capacity switch alternator) and the RAISE and LOWER speed control buttons for the aerial assembly. Also on the panel are START and STOP buttons and indicator lights for the transmitter.

(3) **Control unit 620**—This unit houses the controls for the 79 turning gear. Controls provide for the selection of clockwise or counter-clockwise rotation, position-laying and synchronizing with the rotation of the Type 7 aerial assembly. A meter on the unit indicates the magnitude of any error between the IFF cabin position and that of the Type 7 aerial assembly.

Spare units

25. Spare units for rack assemblies 318, 318A, 330, are provided and are either accommodated in blank positions in the racks or stored in the spares cupboards.

Machine room

Ward-Leonard set and DC control board

26. The Ward-Leonard motor generator set, motor generator 81 (10KB/1062), consists of a 24 h.p. three-phase motor driving a 2kW 230V DC exciter and a 13.5 kW 230V DC generator. The field of the DC generator is controlled by a motor-driven rheostat on the DC control board. The output of the generator is fed to the aerial driving motor and, by varying the field current, the aerial can be made to turn at any speed up to 6 r.p.m. In addition the DC control board houses auxiliary circuits for the Ward-Leonard control gear, and a voltage regulator for the exciter output.

Capacity switch supplies

27. The 230V DC output of the exciter on the Ward-Leonard set also supplies the field current for the two alternators in the capacity switch and is used to drive the alternator unit 3A. This alternator has its field controlled by a variable rheostat on the panel, meter (p.r.f.) 871 in the apparatus room and this controls its speed of rotation. The alternator supplies a three-phase output at a frequency of between 16 and 22 c/s for driving the capacity switch. The voltage of the three-phase supply is set by a control on the DC control panel.

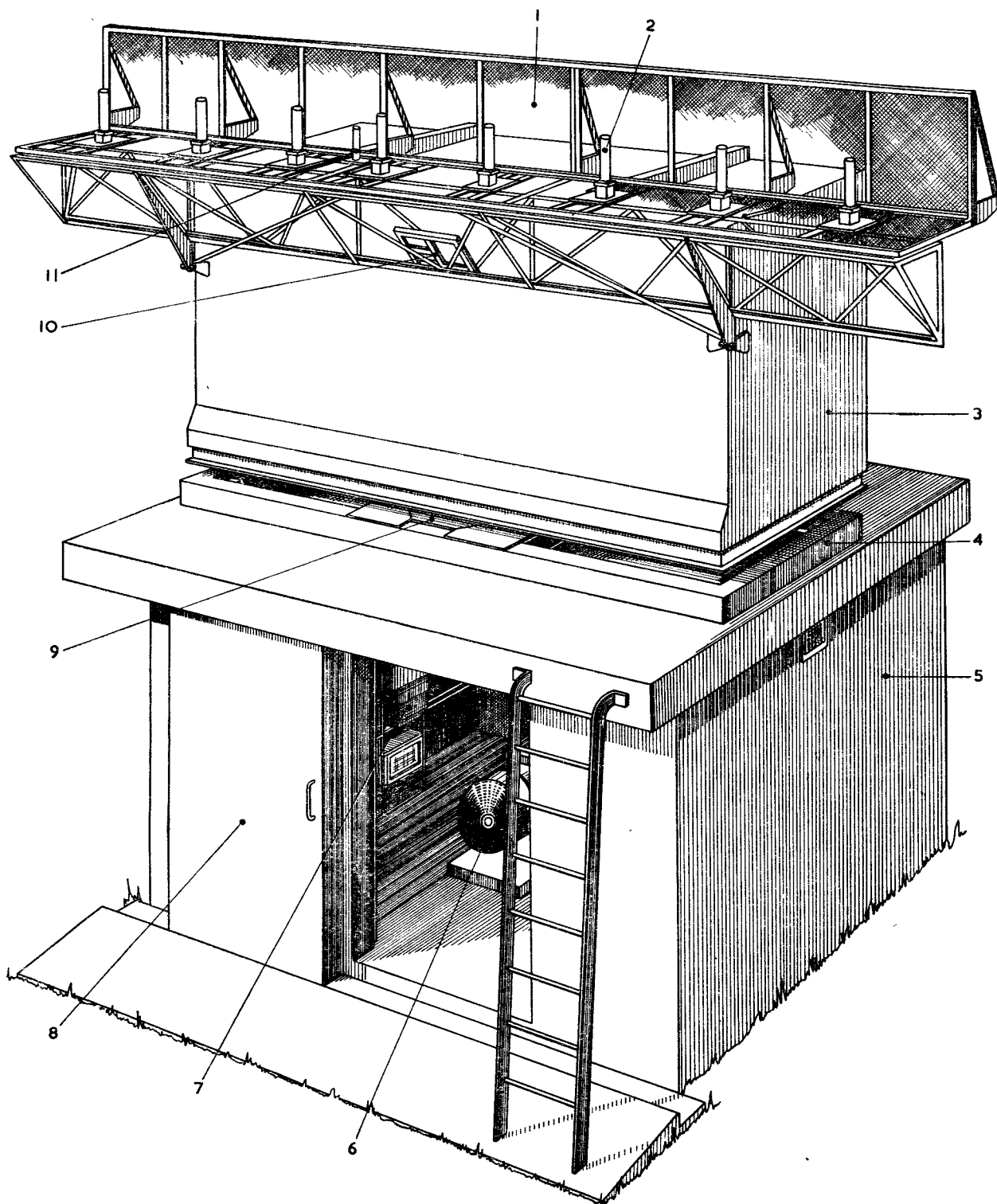
Fan

28. A fan assembly 26 is provided in the machine room and this provides air cooling via a tube in the cable duct for rack assemblies 183 and 318 (or 183A and 318A) in the apparatus room. The 50V supply for the fan contactor is supplied by the rectifier unit 17.

Power supplies

29. Power supplies for the transmitter well are obtained from an external 400/230v, 50 c/s, three-phase supply. The three-phase supply is taken to a switchboard in the machine room and from there supplies are taken to the transmitter compartment (R and B phases), the apparatus

(A.L.2, Nov. 55)



- 1 IFF ARRAY
- 2 IFF UNIPOLE
- 3 CABIN HOUSING IFF EQUIPMENT
- 4 MOUNTING FRAME

- 5 PLINTH
- 6 AMPLIDYNE GENERATOR
- 7 PLINTH TERMINATION RACK
- 8 BLAST-PROOF DOOR

- 9 PIVOT MOUNT
- 10 AERIAL TRANSFORMER
- 11 MONITOR UNIPOLE

Fig. 5. IFF equipment on plinth

room (Y phase) excluding amplifier (servo) 297 and control unit 600 which are fed from R phase and the external IFF equipment (R phase). The three-phase supply is fed to the Ward-Leonard generator set in the machine room and to the amplidyne generator in the plinth.

30. The Ward-Leonard generator set provides a 230V DC supply for the alternator unit 3A and the field winding of the aerial turning motor and, in addition, a zero to 230V supply for the armature of this motor. Variations in the speed of rotation of the aerial assembly is obtained by varying the output of the Ward-Leonard set. The controls for doing this are in the apparatus room, on the control unit (training) 618.

IFF equipment (radar 79 Mk. 1)

31. The IFF equipment provided on radar 79 Mk. 1 is G-band equipment operating on a fixed frequency of 209 Mc/s. The IFF equipment is mounted in a cabin on a mounting frame on top of a plinth by means of a pivot mount so that it can rotate. The cabin contains two separate groups of equipment.

- (1) Cabin turning gear.
- (2) IFF equipment.

Cabin and plinth

32. The cabin is identical with that used on the radar 14 Mk. 8 and 9 and is supported on the identical design of pivot mount and mounting frame. The plinth, too, is of the same standard design with the same head termination rack and amplidyne unit.

33. The cabin is made of light alloy and is double-skinned, the cavity between the walls being filled with thermally insulating material (Isoflex). Two doors on the rear of the cabin give access to the interior; the doors are fitted with rubber sealing strips and cam-type hinges and catches so that they can be sealed against weather, etc., by the operation of two levers. As there is not equipment in the right-hand compartment of the cabin, this door need not be opened.

34. A folding platform is provided at the rear of the cabin. This platform folds up over the closed doors for storage, or if desired, for rotation, though this is not actually necessary.

35. Access to the aerial array on the top of the cabin is provided by a ladder on one end (the left-hand end when looking at the door side) and the top of the cabin is covered with non-slip sheeting. A ladder on the side of the plinth gives access to the top of the plinth and so to the cabin.

36. Cabin ventilation is the same as for the radar 14 Mk. 8 and 9, that is, by means of an axial flow fan mounted in air trunking on one end of the cabin. The standard design of locking device is fitted to the mounting frame for preventing rotation of the cabin, when desired.

37. As the standard pivot mount is used (Air Publication 2886H), the repeat-back selsyn, the heading line switch and auto-align switch are fitted, but they are not used. The standard slip-ring unit is also fitted, but only certain slip-rings are used.

Cabin turning gear

38. The turning gear is the same as that fitted to the radar 14 Mk. 8 and 9 etc. The amplidyne generator is mounted in the plinth and is driven by a 400/230V 45–65 c/s, three-phase, squirrel-cage induction motor.

39. The turning gear is normally controlled by control panel 620 in the transmitter well apparatus room but the local control unit (training) 602, in the cabin, can be switched to take over control of the servo system for testing and other purposes. This unit is mounted in the cabin beneath the control unit 621 and near to the IFF equipment and incorporates a local/remote control switch and a position-laying control.

Cabin power supplies

40. All 230V AC 45–65 c/s single-phase supplies in the cabin are obtained from the control panel 621 which is fed from one phase (R) of the main supply for the station. The station three-phase supply is also used to feed the motor driving the amplidyne. These supplies are controlled by the switchboard in the well machine room.

Telephone

41. Telephone sets are provided for intercommunication between the transmitter well and IFF cabin.

Equipment in cabin

42. The IFF equipment includes:—

(1) *Units mounted on an apparatus rack just inside the left-hand door:—*

Transmitter T.3686.
Modulator 239.
Rectifier R.3684.
Amplifier A.3687.
Monitor 61.
Box, junction, 367.

(2) *Units mounted on the cabin wall:—*
Matching assembly 28.
Switch unit 271.

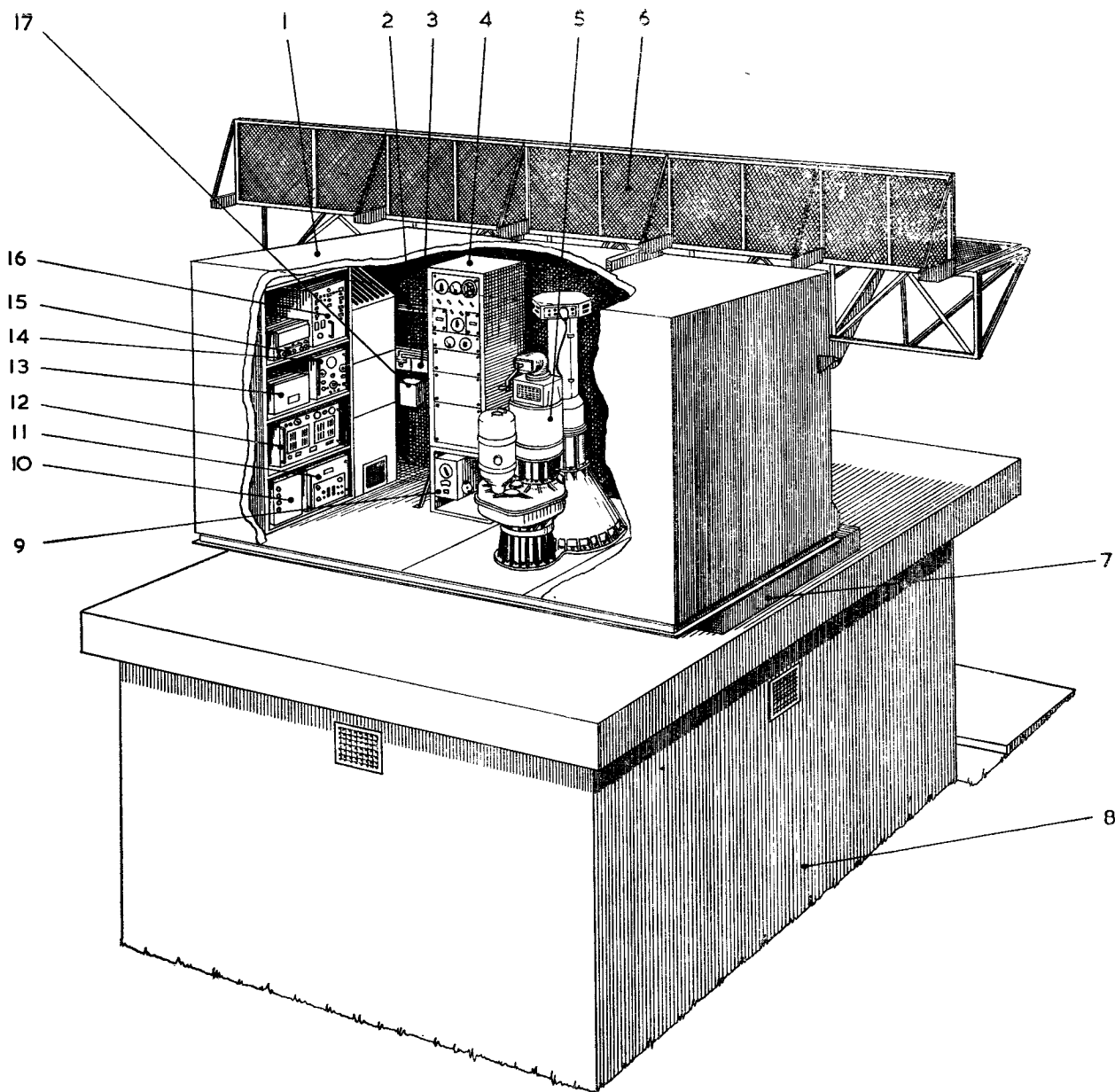
(3) *Units mounted on the outside of the cabin:—*

Aerial assembly, complete, including:—
Frame, aerial, 107.
Rods, aerial, 288—eight.
Rods, aerial, 345—one.
Feeders, aerial, 146.
Transformer, aerial, 6.

43. The units constituting the IFF do not differ in principle from the original IFF Mk. 3, but they are somewhat rearranged internally to permit the use of improved components and a more unified system of plugs and sockets. The wide band IFF aerial covers the whole IFF band of 157–120 Mc/s, with common T & R facilities with a standing-wave ratio of 2:1.

44. The remaining units in the cabin are associated with power supply distribution and turning gear. They are:—

Control unit 621.
Rectifier unit 67.
Control unit (training) 602.



- 1 CABIN
- 2 MATCHING ASSEMBLY TYPE 28
- 3 SWITCH UNIT TYPE 271
- 4 CONTROL PANEL TYPE 621
- 5 PIVOT MOUNT
- 6 IFF ARRAY
- 7 MOUNTING FRAME
- 8 PLINTH
- 9 CONTROL UNIT (TRAINING) TYPE 602

- 10 BOX, JUNCTION, TYPE 367
- 11 RECTIFIER TYPE 67
- 12 TRANSMITTER TYPE T.3686
- 13 AMPLIFIER TYPE A.3687
- 14 MONITOR TYPE 61
- 15 RECEIVER TYPE R.3684
- 16 MODULATOR TYPE 239
- 17 HUMIDITY DETECTOR

Fig. 6. Interior of IFF cabin

SECTION 2

WELL AND AERIAL FRAME

Introduction

1. There are two varieties of transmitter well and the type used depends upon the situation of the aerial head with respect to the operations centre. On radar Type 7 Mk. 2, where the aerial site is near the site of the operations centre, the well contains only the equipment directly associated with the radar and consists of one room. On radar Type 7 Mk. 3 the aerial site may be a distance of up to several miles away from the operations centre for operational or other reasons such as the unsuitability of the aerial site for extensive underground works. Certain of the equipment which would normally be housed in the station radar office and machine room, is then housed in the transmitter well, which for this reason is made considerably larger and consists of three rooms, one containing the radar equipment proper, one containing the control equipment and one the turning gear generator and associated equipment.

2. Both transmitter wells are built underground and are constructed of reinforced concrete. The depth of the well floor below ground level will depend upon the site; in general the top of the reinforced concrete roof is at about ground level.

RADAR TYPE 7 Mk. 2

3. In this installation the well consists of one room only, 20 ft. long, 12 ft. 6 in. wide, and 7 ft. 6 in. high. The central pillar which supports the aerial framework is mounted directly above the centre of the roof of the well. The roof has a large hole in it under this pillar so that the vertical feeder to the rotating coupling unit in the capacity switch cubicle, and the various connections between the aerial frame and the well, can be run up the inside of the central pillar (*fig. 2*).

4. The well is provided with three hatches in the roof. One of these is an entrance hatch while the other two are equipment hatches through which equipment can be lowered into or removed from the well during installation and maintenance. The equipment hatches are fitted with covers which are secured in place by bolts and padlocks. The entrance hatch has a hinged cover fitted with a counterbalance weight, for ease of opening.

Facilities

5. The well houses the radar equipment and auxiliary equipment associated with it. The only

equipment external to the well is the safety switch, the aerial framework and turning motor, and the capacity switch. A single-phase AC switchboard in the well controls supplies to all units and services, each outlet feeding a separate item of equipment being separately fused. Fig. 9 (at end of chapter) shows the layout of electrical equipment in the well.

6. Units in the well provide the following facilities:—

- (1) Selection of either of the two transmitters
- (2) Selection of either of the two receivers
- (3) Control of the voltage output of the MSW and $\frac{1}{4}$ p.r.f. alternators in the capacity switch
- (4) Phasing of the $\frac{1}{4}$ p.r.f. waveforms
- (5) Testing of the receiver noise factor.

7. Facilities are provided for heating the well, wall-mounted heaters being provided at convenient points. No separate ventilation system is pro-

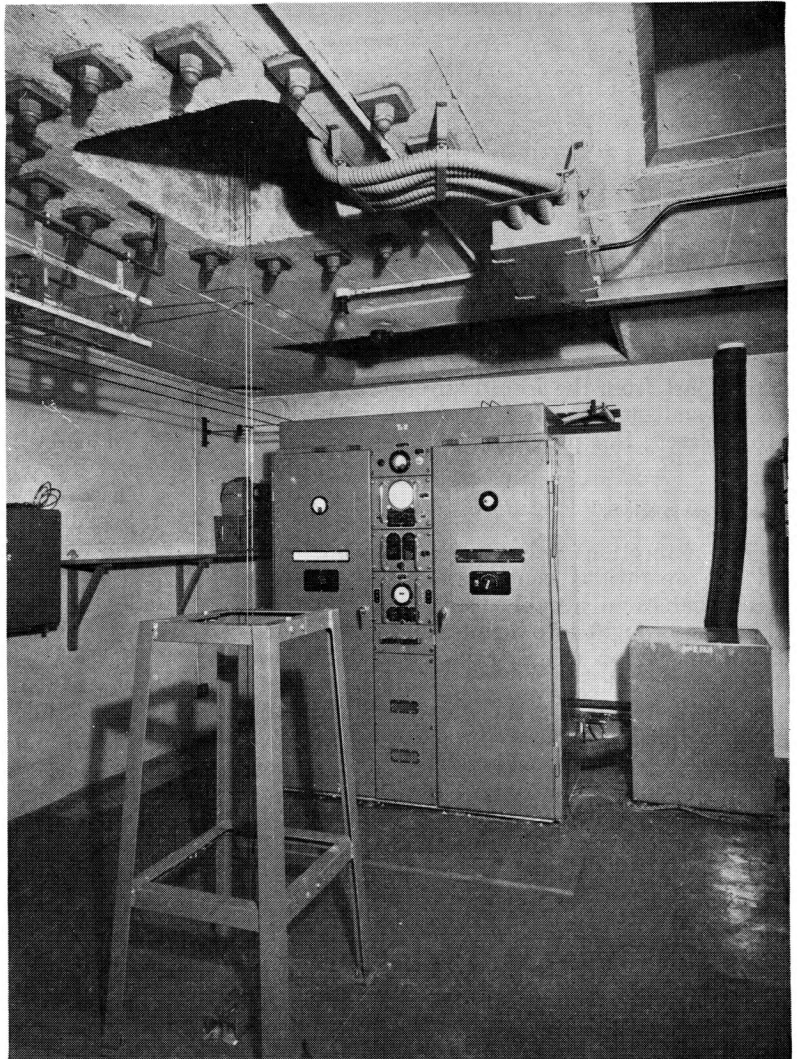


Fig. 2. General view of transmitter well

(A.L.12, Jan. 57)

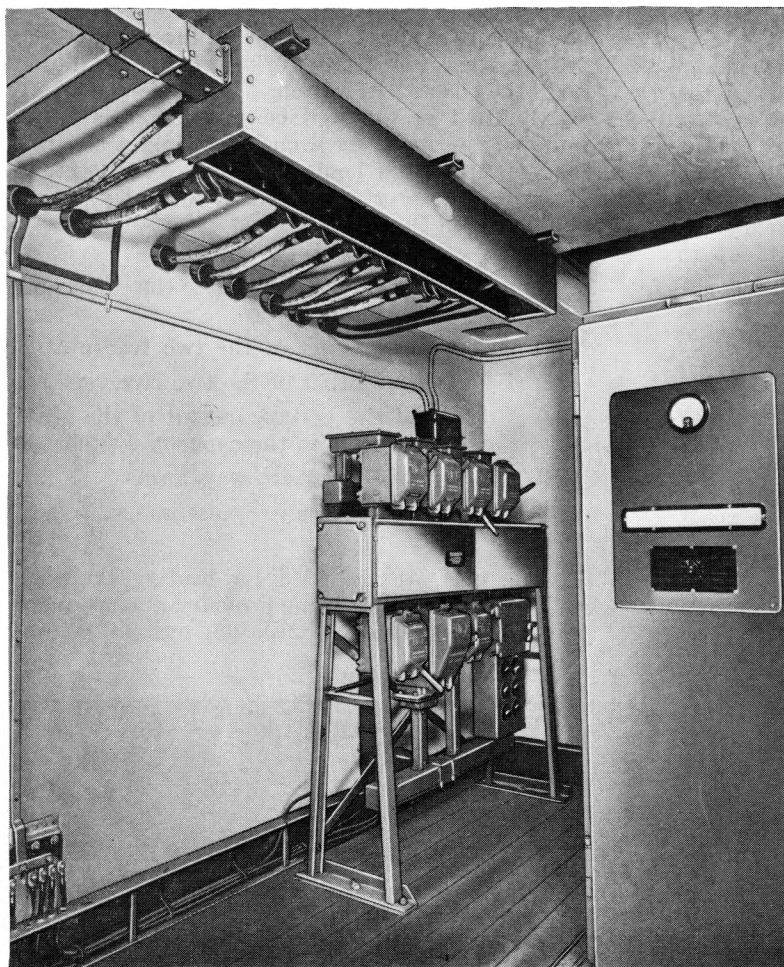


Fig. 3. Radar Type 7 Mk. 2—cable entry and switchboard

vided apart from the forced air-cooling system for the transmitter, the air from which is discharged into the well; this provides adequate ventilation.

External connections

8. All connections between the transmitter well and the operations centre are made by underground cables in a cable trench (*fig. 3*). These cables are brought into a junction box in the well via an inspection chamber just outside the well. The inspection chamber is 4 ft. 6 in. long, 2 ft. 9 in. wide, and 1 ft. deep and includes a sealing chamber which is filled with sealing compound after the cables are laid. The cable armouring terminates in the main compartment of the inspection chamber and the lead-covered cables are routed through a number of pipes into the well where they are terminated in a junction box mounted on the ceiling.

9. Wiring between the well, safety switch and turning gear motor is taken from the well junction box, via the inspection chamber and the cable trench. Two lengths of $1\frac{1}{2}$ in. diameter conduit, buried on the top of the well roof, run between the cable trench and the turning gear housing.

Internal wiring

10. The wiring from the junction box in the well ceiling is taken through two 3 in. $\times$ 3 in. trunks to the main 6 in. $\times$ 3 in. trunking around the bottom of the well walls and thence to the individual items of equipment. Wiring between units in the well is also taken through the trunking the most convenient path being used. Full details of the wiring within the well will be found in *fig. 10* at end of chapter. A 3 in. $\times$ 3 in. trunking branch runs from one of the 3 in. $\times$ 3 in. trunks, connecting the ceiling-mounted junction box to the main 6 in. $\times$ 3 in. trunking; this branch is terminated in a small junction box from which five flexible conduits are run to join up with those inside the central supporting pillar of the aerial framework. These conduits carry supplies to the capacity switch cubicle and to the selsyns.

Power distribution

11. All equipment in the well is operated from a common single-phase 230V, 50 c/s supply brought to the well over a 2-core 37/-072 P.I.L.C.S.W.A (paper-insulated lead-covered steel wire armoured) cable to the well junction box and thence to the single-phase AC switchboard in the corner of the well (*fig. 3*). This switchboard feeds the two transmitters and their fan assemblies on four major switched, fused outlets and the remaining items of equipment from six subsidiary switched, fused outlets. One major outlet on the switchboard is provided for feeding the well heating and lighting circuits.

Heating

12. Thermostatically-controlled tubular electric heaters are provided, one being mounted on the wall of the well behind each transmitter. The size and rating of the heaters may vary from installation to installation as in many instances reconditioned wells are used. A typical installation has two 8 ft. heaters, each rated at 960W.

Cooling and ventilation

13. Fan assemblies Type 26 (*Sect. 3, Chap. 1*) provide forced air cooling of the transmitters, on the Mk. 2. Two of these units are provided in the transmitter compartment (one for each transmitter).

14. Air from the external atmosphere is drawn through ventilation cowls on the roofs of the wells via flexible hose to air filters on the inlets of the

fans. Additional cowls in the rooms provide a suitable escape path for the exhaust air. Each fan handles air at the rate of 385 to 565 cubic feet per minute at a pressure of 7 to 10 in. water gauge.

15. The fans in the transmitter compartment are switched on automatically with the equipments which they cool and normally it is impossible to switch the fans on without the equipment.

RADAR TYPE 7 Mk. 3

16. In this installation the well consists of three rooms. The transmitter compartment is 20 ft. long, 12 ft. 6 in. wide, and 8 ft. high, the apparatus room 12 ft. 5 in. long, 12 ft. 6 in. wide and 8 ft. high and the well machine room 15 ft. 2 in. long 12 ft. 6 in. wide and 8 ft. high. The underground chamber containing these rooms and their partitions is about 50 ft. $\times$ 12 ft. 6 in. $\times$ 8 ft. The central pillar which supports the aerial framework is mounted directly above the centre of the roof of the transmitter compartment and the various connections to the aerial frame are taken through a hole in the roof and up the inside of the pillar in exactly the same way as for the Mk. 2 (*fig. 2*).

17. The well is provided with two entrance hatches and four equipment hatches. The transmitter compartment and the machine room each has an entrance hatch. There are two equipment hatches in the transmitter compartment and one each in the other two rooms, these being sealed as before.

Facilities

18. In addition to housing the radar equipment and auxiliary apparatus, the well also contains the master trigger unit, the control equipment for the radar and IFF and the Ward-Leonard control gear for the Type 7 aerial. *Fig. 11* shows the layout of the electrical equipment in the well. The Type 7 aerial, turning motor, safety switch and IFF equipment are mounted external to the transmitter well, the IFF equipment being on a separate plinth. The units in the transmitter compartment provide the same facilities as those in the local well (*para. 6*). The units in the apparatus compartment provide:—

- (1) Switching on and off of selected transmitter.
- (2) Starting and stopping of aerial and capacity switch.

(3) Control of pulse recurrence frequency.

(4) Control of IFF turning gear.

(5) Step-up of selsyn output voltages for transmission over lines to the operations centre.

(6) Amplification of radar and IFF outputs to a suitable level for transmission to the operations centre.

External connections (*fig. 8*)

19. All connections between the well and the operations centre are made by underground cables installed and maintained by the G.P.O. Other cables coming into the well are the power supply cables and the cables from the radar Type 79 Mk. 1 which is installed on the aerial site some distance from radar Type 7. The G.P.O. cables are brought directly into the centre (apparatus) compartment of the well and are terminated on a G.P.O. termination board mounted on the partition wall between the transmitter and apparatus compartments

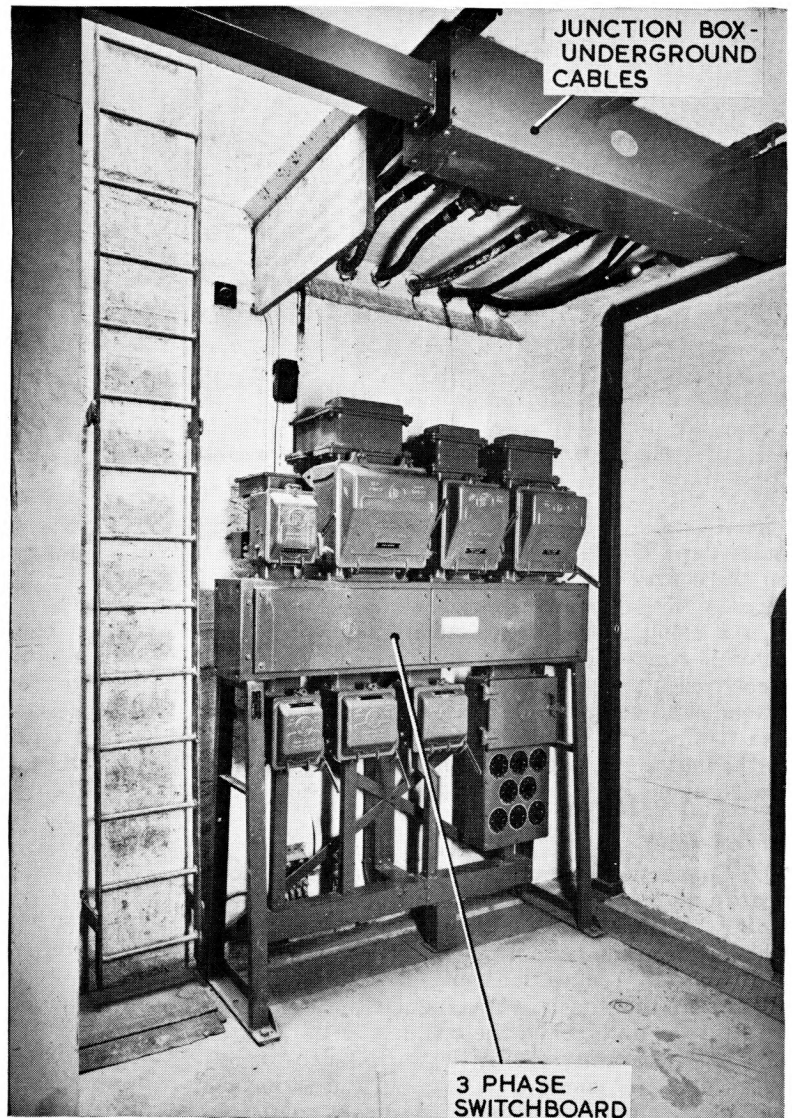


Fig. 4. Radar Type 7 Mk. 3—cable entry and switchboard

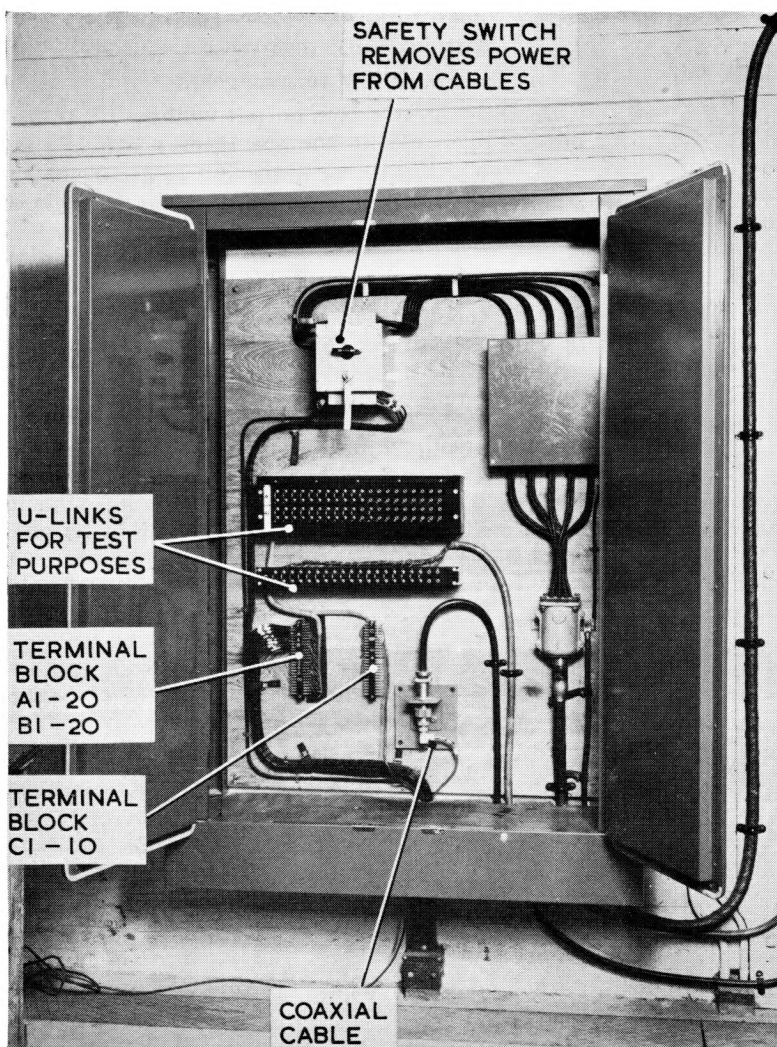


Fig. 5. G.P.O. termination board—transmitter well

(fig. 5 and 6). The underground cables to the radar Type 79 Mk. 1 are taken from a junction box on the ceiling of the well machine room, through pipes in the wall to an inspection chamber, and then into a cable trench in a similar manner to the external connections for the local well. The cable trench leads to the radar Type 79 Mk. 1 and is also extended to carry the cables to the safety switch and to the aerial frame driving motor, the cables to the motor being taken to the motor housing by two $1\frac{1}{2}$ in. conduits buried on top of the well.

Internal wiring

20. Connections from the G.P.O. termination board and from the cable junction box are taken by 3 in. $\times$ 3 in. trunking to a covered cable trench which runs around the floor of the well at the foot of the walls. Connections to individual units are taken from the trench by rectangular trunks up the walls to the units, or in the instance of the Ward-Leonard generating set in the machine room, by $1\frac{1}{2}$ in. diameter conduit. Details of the wiring in the transmitter compartment, apparatus compartment and machine room are given in fig. 12, 13 and 14.

Power distribution

21. In this installation a 400/230V 50 c/s three-phase AC supply is used. It is brought into junction box on the roof of the well machine room via a 4-core 19/064 P.I.L.C.S.W.A. cable and thence to a three-phase switchboard in the corner of the room (fig. 4). From the switchboard, two phases (*yellow* and *blue*) are taken to a switchboard in the transmitter compartment which feeds the equipment in that compartment as in the local well except that the two transmitters and their blowers are run off *blue* phase while the *yellow* phase feeds the lighting and heating circuits.

22. The apparatus room is fed off the *red* phase, individual circuits being fed off six subsidiary outlets on the three-phase switchboard.

23. The fan assembly Type 26 in the machine room is run off the *yellow* phase, while the three-phase and neutral supply is fed to the Ward-Leonard control equipment. In addition, a three-phase supply is fed by underground cable to the radar Type 79 Mk. 1 where it is used to drive the turning gear. Also taken from the switchboard is a single-phase supply (*red* and *neutral*) which feeds the IFF equipment.

24. The well lighting and heating circuits are taken off the two-phase board (*yellow* and *neutral*) in the transmitter compartment, in a similar manner to the local well.

Heating

25. Thermostatically-controlled tubular electric heaters are provided in all rooms. In the transmitter compartment, one heater is mounted behind each transmitter; these heaters are 10 ft. and 5 ft. long and rated at 1,200W and 600W respectively. In the apparatus room, a 5 ft. heater, rated at 900W, is mounted on the wall by the rest space. In the machine room, an 8 ft. heater, rated at 1,440W, is mounted on the wall near the Ward-Leonard generator set.

Cooling and ventilation

26. Fan assemblies Type 26 (Sect. 3, Chap. 1) provide forced air cooling of the transmitters and rack assemblies on the Mk. 3. On the Mk. 3, two of these units are provided in the transmitter compartment (one for each transmitter), and another of these units is provided in the well machine room, to cool the rack assemblies Type 183 and Type 318, in the apparatus room, via flexible hose laid in the cable duct.

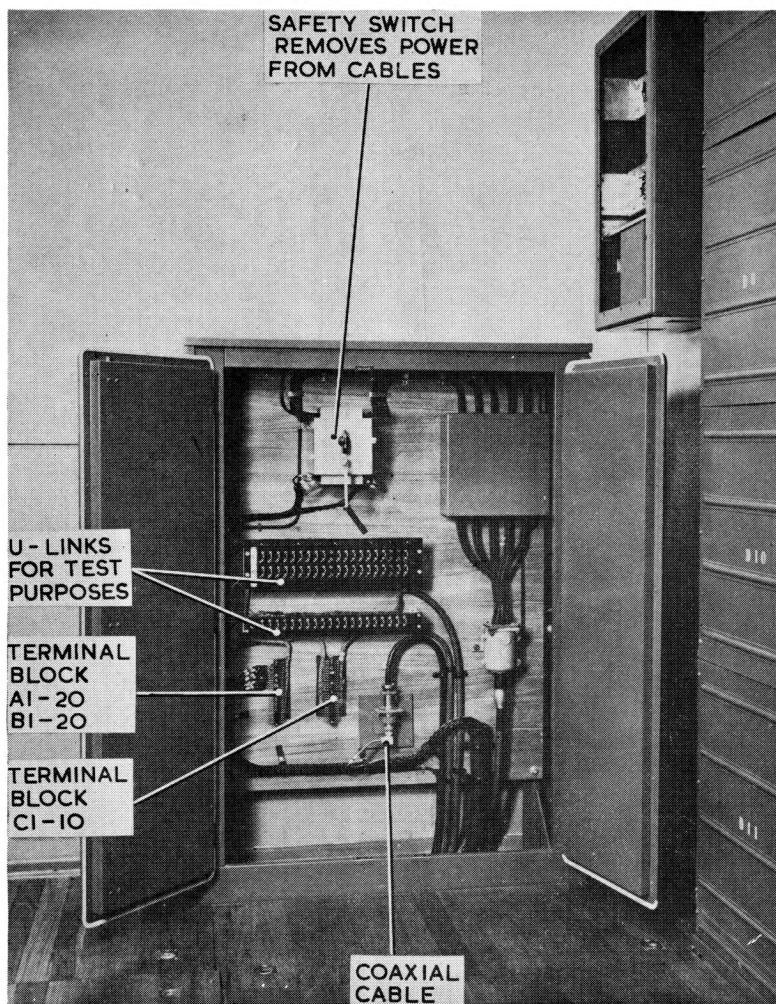


Fig. 6. G.P.O. termination board—radar office

27. Air from external atmosphere is drawn through ventilation cowls on the roofs of the wells via flexible hose to air filters on the inlets of the fans. Additional cowls in the rooms provide a suitable escape path for the exhaust air. Each fan handles air at the rate of 385 to 565 cubic feet per minute at a pressure of 7 to 10 in. water gauge.

28. The fans in the transmitter compartment are switched on automatically with the equipments which they cool and normally it is impossible to switch the fans on without the equipment. The fan in the well machine room is controlled by a separate switch on the main well 3-phase switch-board, but will not start until the 50V power supply in the rack assembly Type 318 is available.

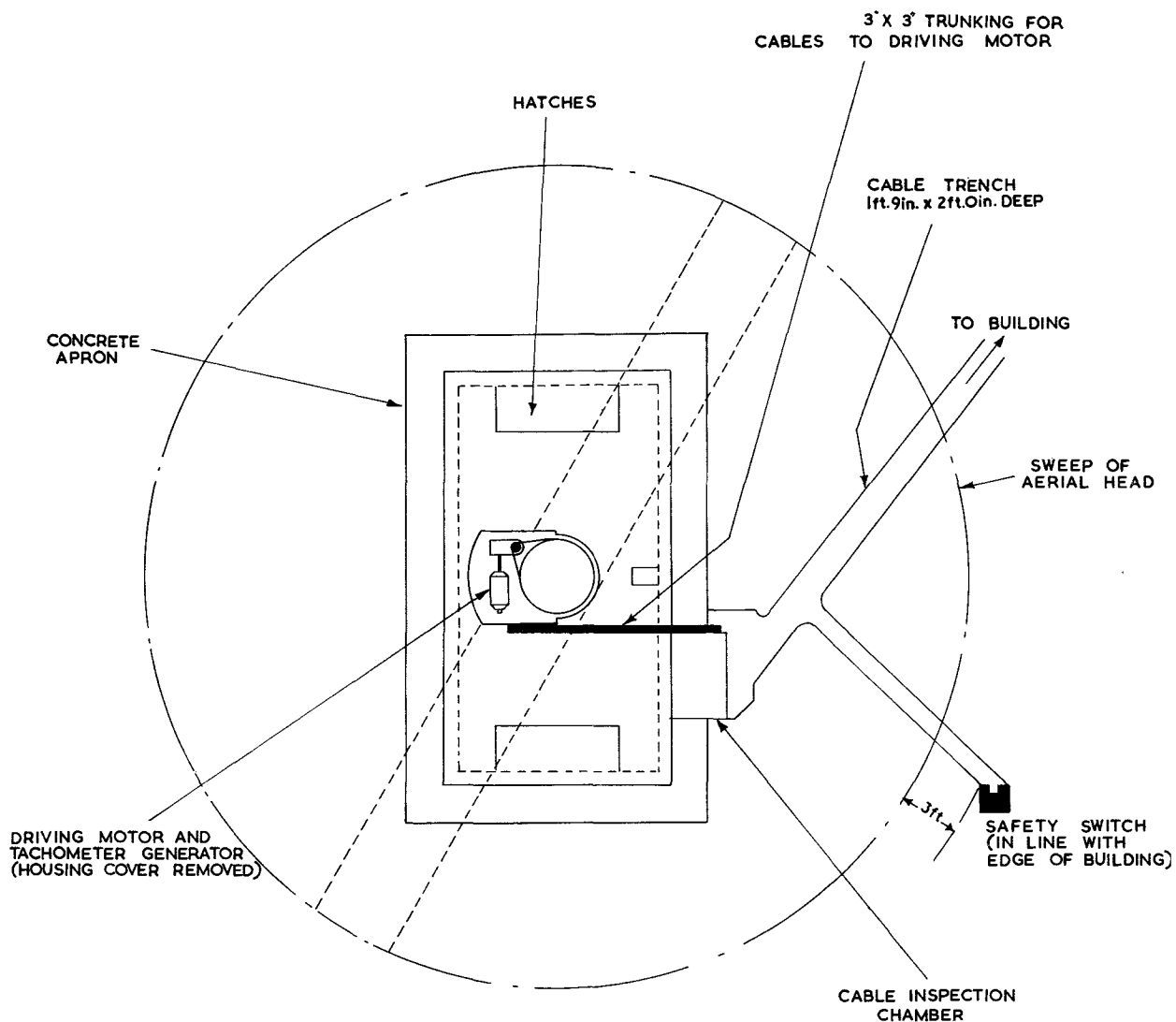


Fig. 7. Radar Type 7 Mk. 2—position of safety switch and external cable runs

Chapter I

TRANSMITTER WELL

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<i>Radar Type 7 Mk. 2—cable entry and switchboard</i>	3	<i>Radar Type 7 Mk. 2—details of wiring in well</i>	10
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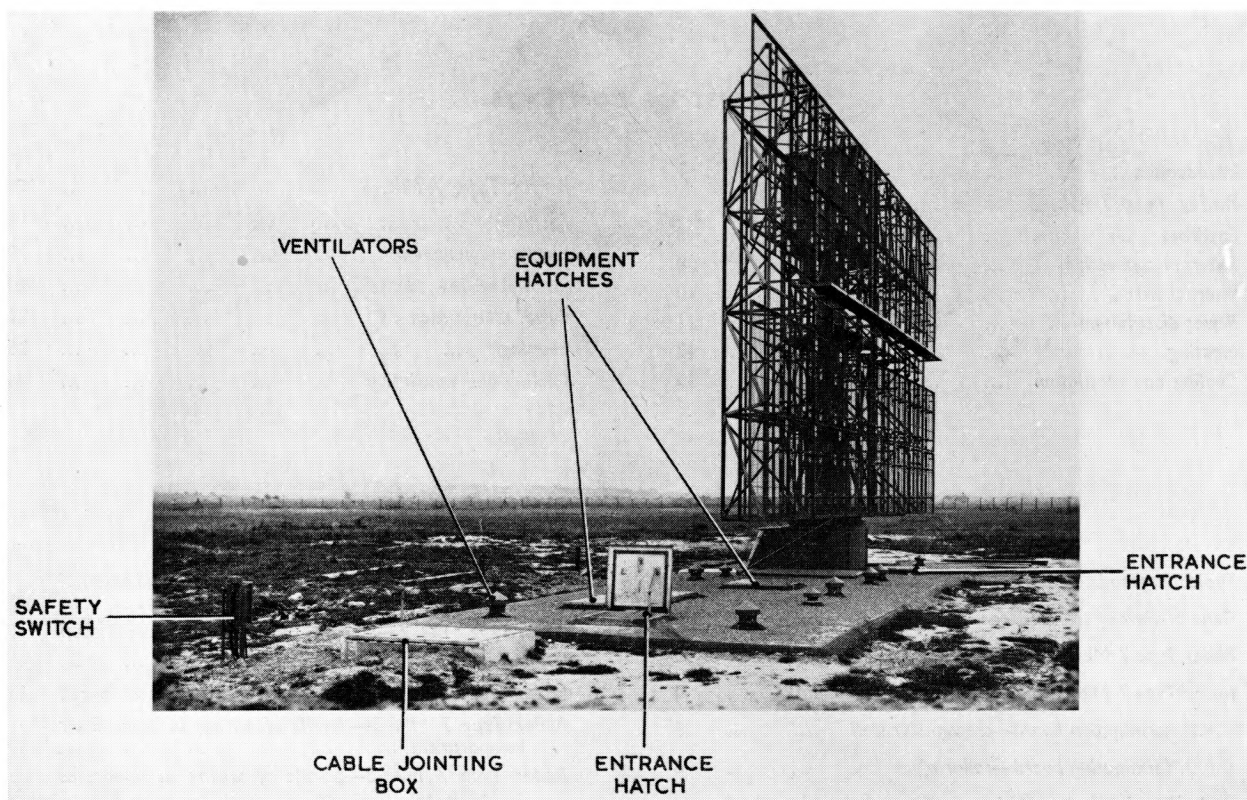


Fig. 1. Typical transmitter well (Radar Type 7 Mk. 3)

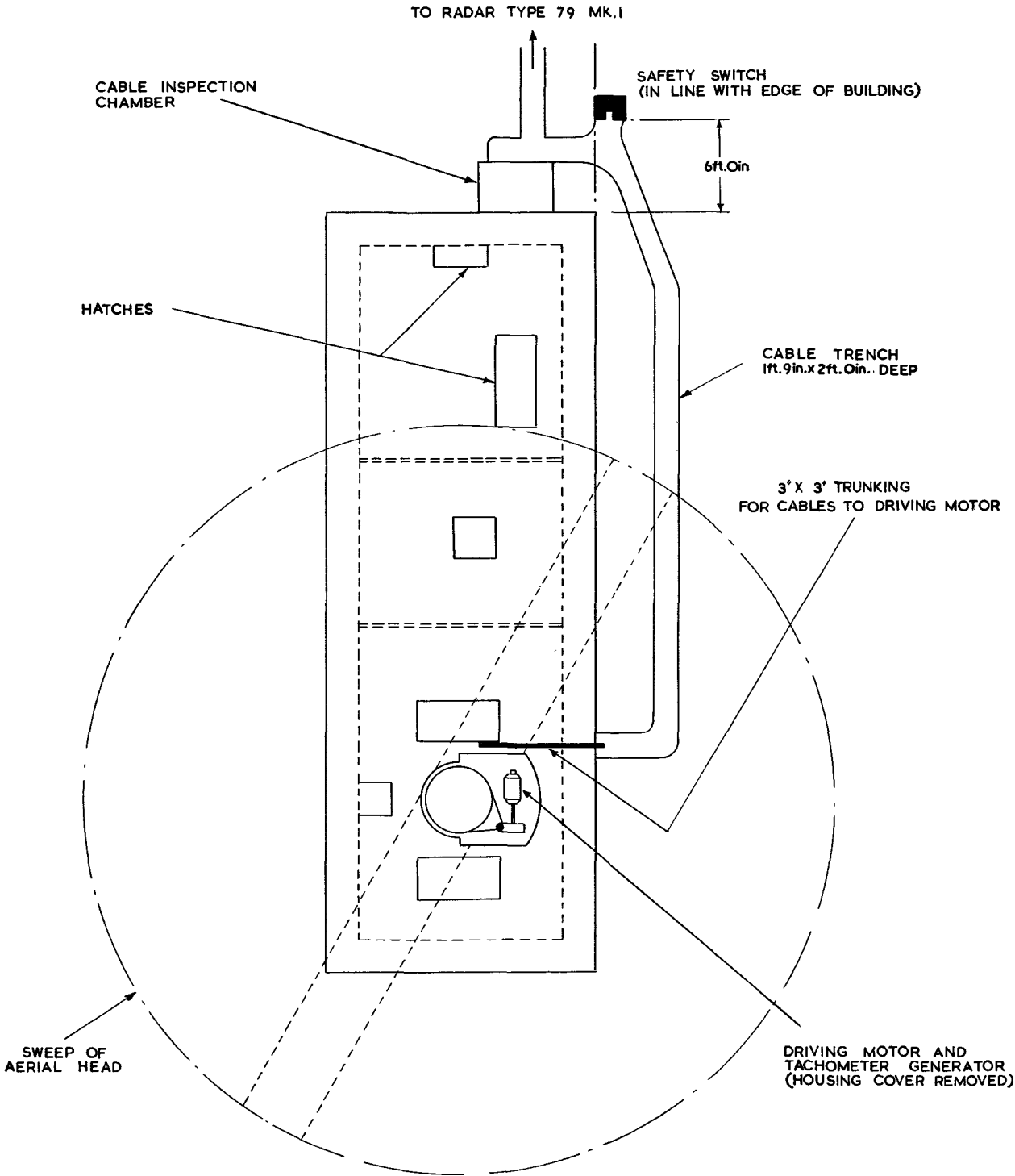
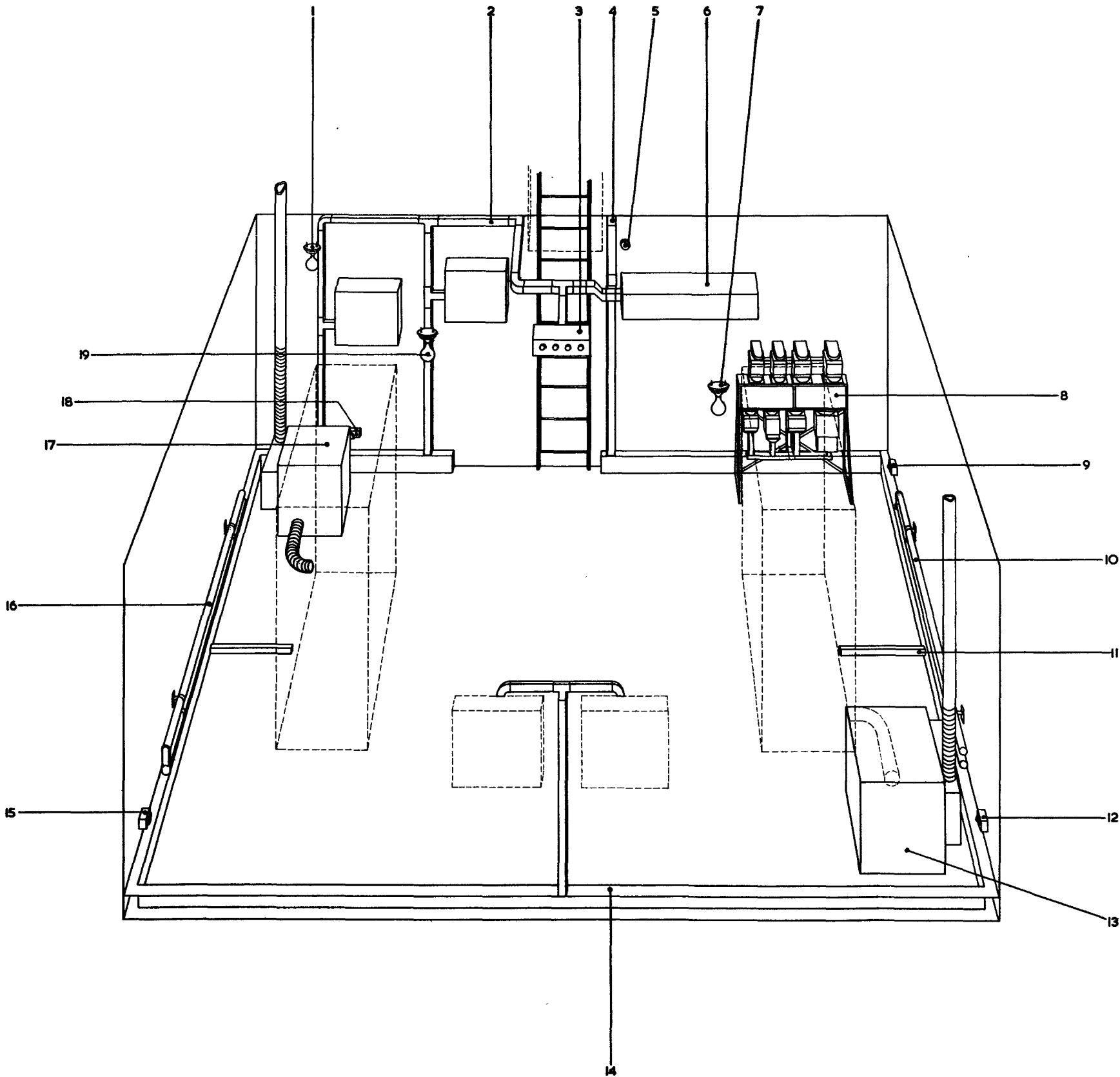


Fig. 8. Radar Type 7 Mk. 3—position of safety switch and external cable runs



KEY

- 1 LIGHT FITTING
- 2 CONDUIT FROM JUNCTION BOX TO MAIN CONDUIT
- 3 COUPLING BOX FOR CUBICLE CONDUITS
- 4 CONDUIT FROM JUNCTION BOX TO MAIN CONDUIT
- 5 LIGHT SWITCH
- 6 JUNCTION BOX
- 7 LIGHT FITTING
- 8 SWITCHBOARD
- 9 POWER POINT
- 10 TUBULAR ELECTRIC HEATER
- 11 CONDUIT TO TRANSMITTER
- 12 POWER POINT
- 13 FAN ASSEMBLY TYPE 26
- 14 MAIN CONDUIT
- 15 POWER POINT
- 16 TUBULAR ELECTRIC HEATER
- 17 FAN ASSEMBLY TYPE 26
- 18 POWER POINT
- 19 LIGHT FITTING

Fig.9

Radar Type 7 Mk.2 - layout of electrical equipment in well

Fig.9.

(AL12 . Jan. 1957)

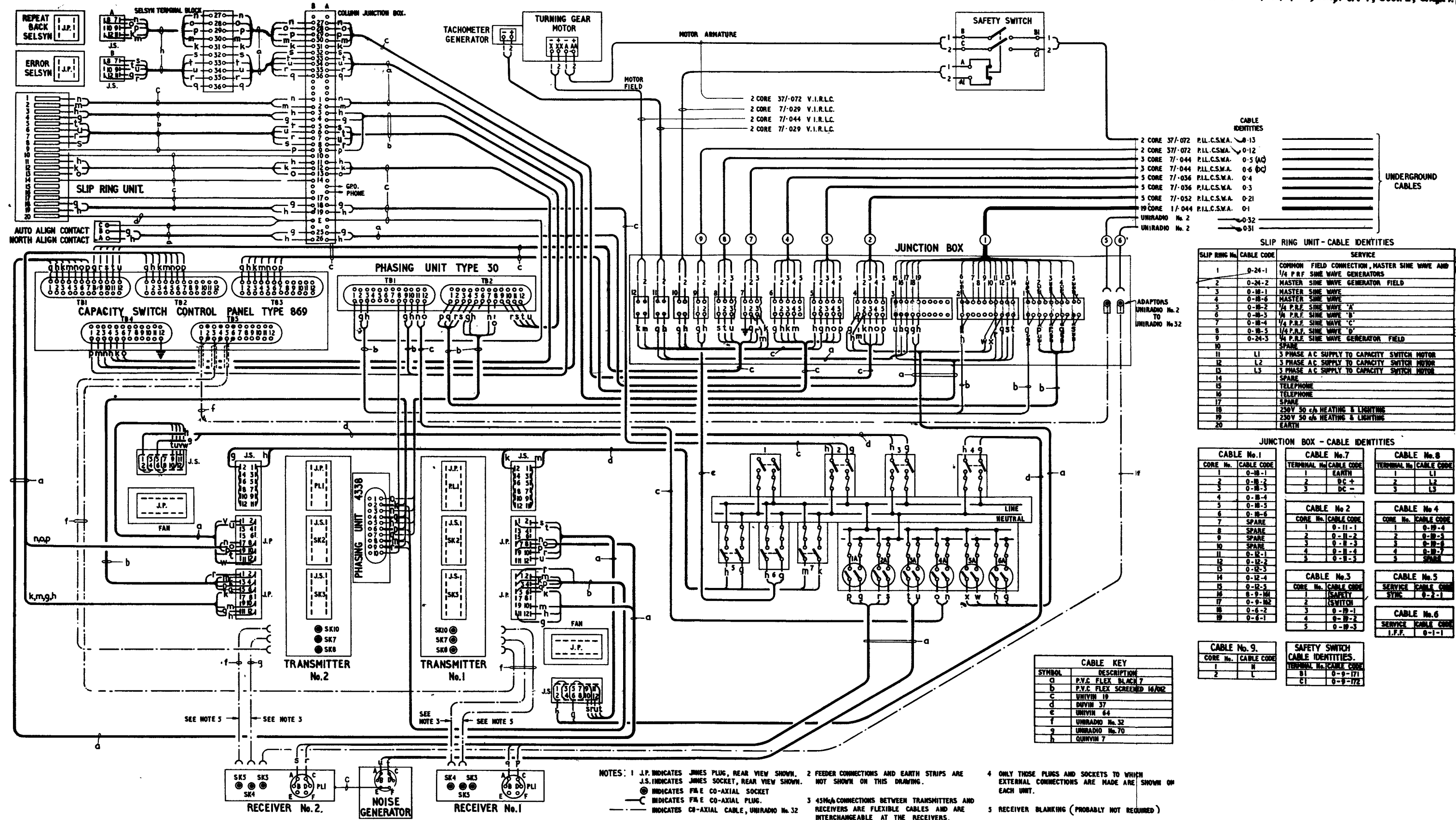


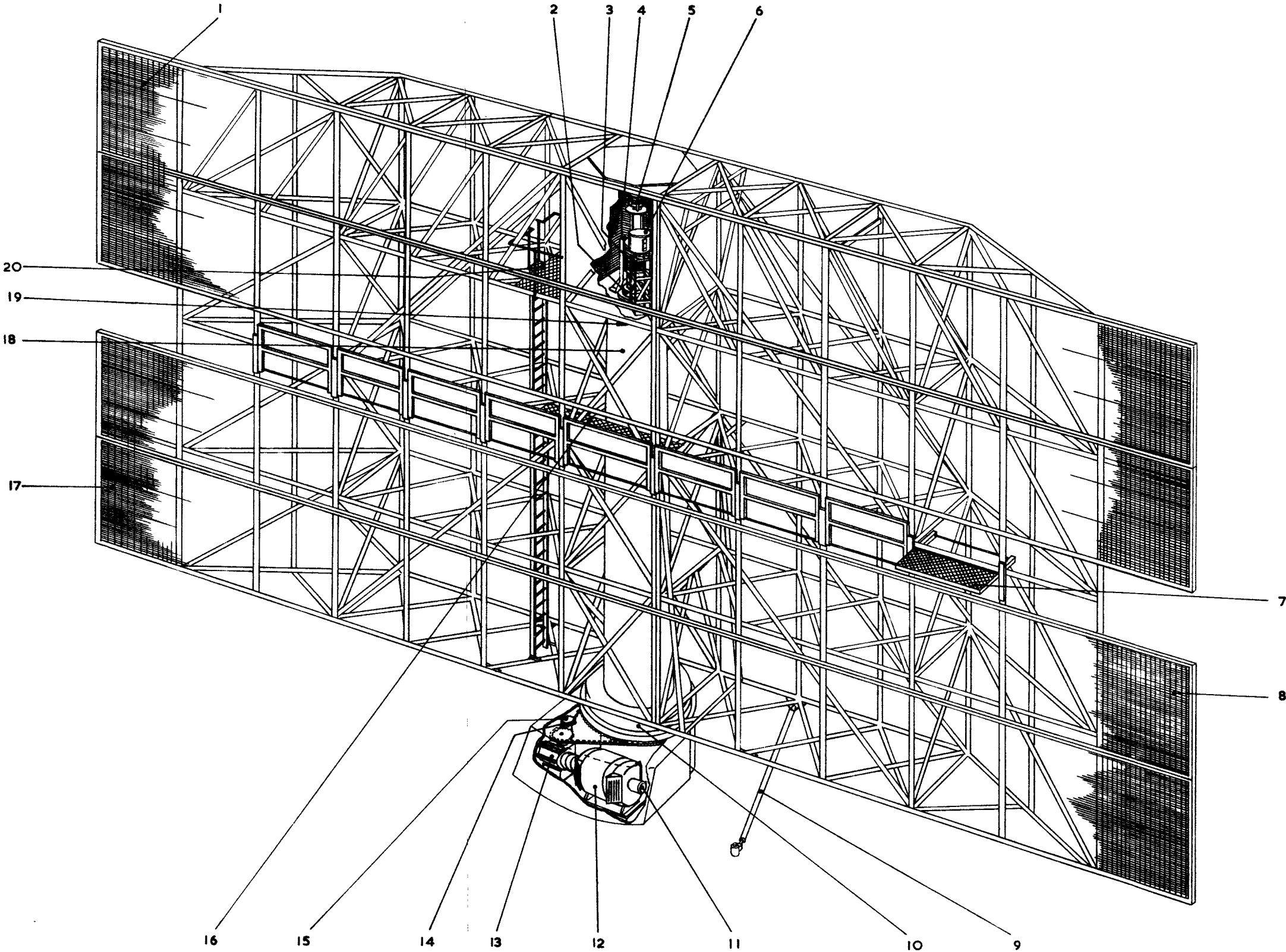
Fig.10

Radar Type 7 Mk.2 — details of wiring in well

Fig.10.

RESTRICTED

(AL 12, Jan 1957)

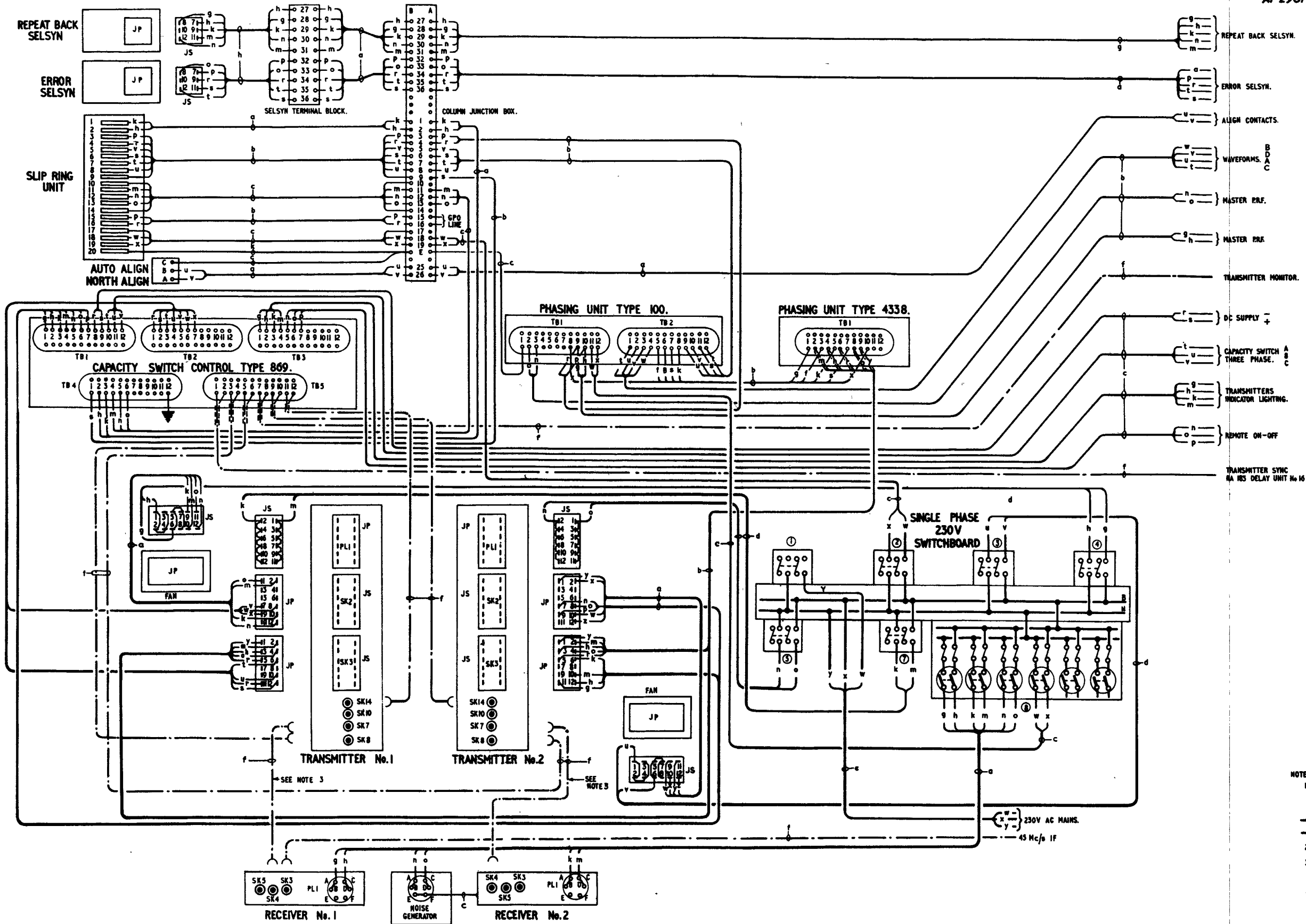


KEY

- 1 TOP ARRAY REFLECTOR.
- 2 TOP BEARING.
- 3 SLIP RING UNIT.
- 4 CAPACITY SWITCH CUBICLE.
- 5 ROTATING COUPLING.
- 6 CAPACITY SWITCH.
- 7 SERVICING PLATFORMS.
- 8 MIDDLE ARRAY REFLECTOR.
- 9 STAY BAR.
- 10 BOTTOM BEARING AND CHAIN WHEEL.
- 11 TACHOMETER GENERATOR.
- 12 AERIAL TURNING MOTOR.
- 13 REDUCTION GEARBOX.
- 14 ROLLER CHAIN.
- 15 JOCKEY SPROCKET.
- 16 SELSYN SERVICING PLATFORM.
- 17 BOTTOM ARRAY REFLECTOR
- 18 CENTRAL COLUMN.
- 19 SELSYNS
- 20 LADDER & PLATFORM.

Fig.2 Aerial Frame.

Fig.2
(A.L.4, Jan. 56)



SLIP RING UNIT - CABLE IDENTITIES.		
SLIP RING N.	CABLE CODE	SERVICE
1	0-24-1	COMMON FIELD CONNECTION MASTER SINE WAVE AND 1/4 PRF SINE WAVE GENERATORS.
2	0-24-2	MASTER SINE WAVE GENERATOR FIELD.
3	0-18-1	MASTER SINE WAVE.
4	0-18-6	- - - - -
5	0-18-2	1/4 PRF SINE WAVE 'A'.
6	0-18-3	- - - - -
7	0-18-4	- - - - -
8	0-18-5	- - - - -
9	0-24-3	1/4 PRF SINE WAVE GENERATOR FIELD.
10		SPARE
11	L1	THREE PHASE SUPPLY TO CAPACITY SWITCH MOTOR
12	L2	- - - - -
13	L3	- - - - -
14	L1	230V 50 c/s HEATING AND LIGHTING
15	NEUTRAL	- - - - -
16	EARTH	EARTH

CABLE KEY	
SYMBOL	DESCRIPTION
a	PVC FLEX BLACK 7
b	PVC FLEX SCREENED 14/012
c	UNIVIN 19
d	DUVIN 37
e	UNIVIN 19
f	UNIVIN 7
g	UNIRADIO No 32
h	QUINVIN 7
k	UNIVIN 37

- NOTES —
1. JP INDICATES JONES PLUG REAR VIEW SHOWN.
JS INDICATES JONES SOCKET REAR VIEW SHOWN.
⊙ INDICATES F & E CO-AXIAL SOCKET.
⊙ INDICATES F & E CO-AXIAL PLUG.
— INDICATES CO-AXIAL CABLE.
 2. FEEDER CONNECTIONS AND EARTH STRIPS ARE NOT SHOWN ON THIS DRAWING.
 3. 45M c/s CONNECTIONS BETWEEN TRANSMITTERS AND RECEIVERS ARE FLEXIBLE CABLES AND ARE INTERCHANGEABLE AT THE RECEIVERS.
 4. ONLY THOSE PLUGS AND SOCKETS TO WHICH EXTERNAL CONNECTIONS ARE MADE ARE SHOWN ON EACH UNIT.

Fig. 12 Radar Type 7 Mk.3.—Details of Wiring in Transmitter Compartment.

Fig.12 (AL 12 Jan. 1957)

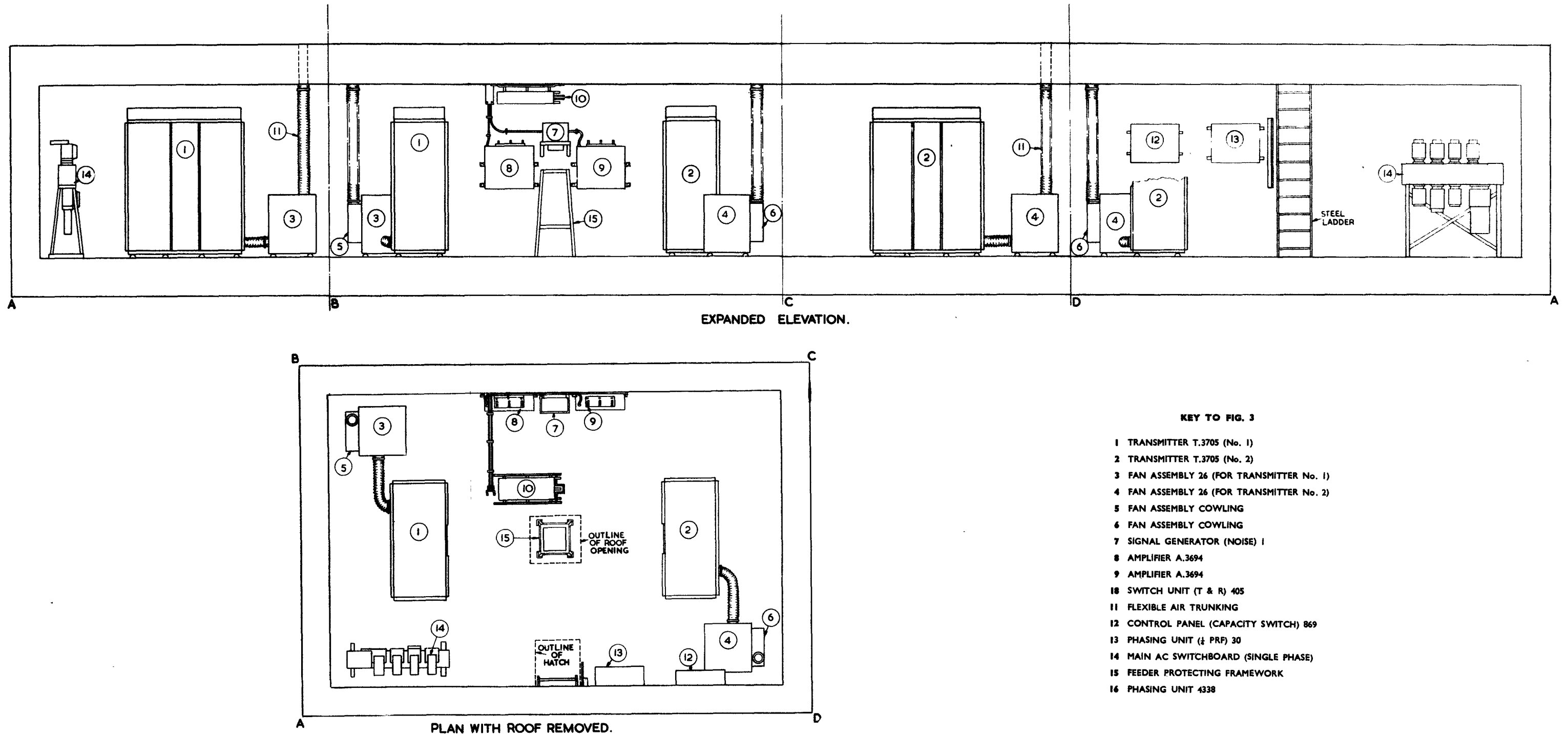
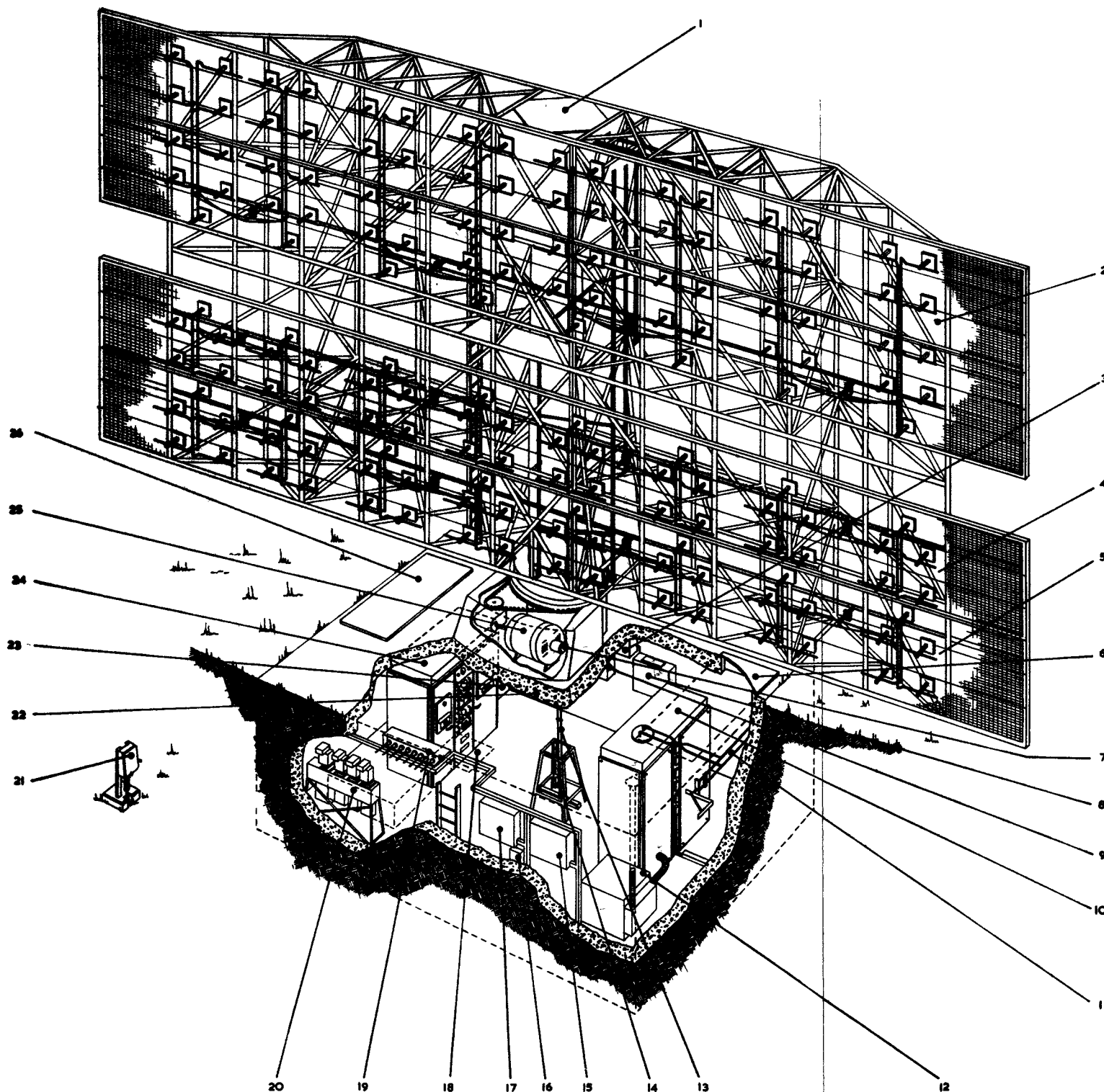


Fig. 3

Layout of Equipment in Well

Fig. 3.



KEY.

- 1 CAPACITY SWITCH CUBICLE.
- 2 TOP ARRAY.
- 3 SIGNAL GENERATOR (NOISE) TYPE 1.
- 4 MIDDLE ARRAY.
- 5 BOTTOM ARRAY.
- 6 EQUIPMENT HATCH.
- 7 AERIAL TACHOMETER-GENERATOR.
- 8 RECEIVER CABINET (AMPLIFIER A-3694.)
- 9 RECEIVER CABINET (AMPLIFIER A-3694.)
- 10 TRANSMITTER T-3705.
- 11 WELL FEEDER NETWORK.
- 12 FAN ASSEMBLY TYPE 26.
- 13 MAIN VERTICAL FEEDER.
- 14 FEEDER PROTECTING FRAME.
- 15 CONTROL PANEL (CAPACITY SWITCH) TYPE 869.
- 16 PHASING UNIT 4338.
- 17 PHASING UNIT ($\frac{1}{4}$ PRF) TYPE 30.
- 18 ENTRANCE HATCH.
- 19 CABLE JUNCTION BOX.
- 20 MAIN SWITCHBOARD.
- 21 SAFETY SWITCH.
- 22 SWITCH UNIT TYPE 405 (ON WELL ROOF.)
- 23 FAN ASSEMBLY TYPE 26.
- 24 TRANSMITTER T-3705.
- 25 AERIAL FRAME DRIVING MOTOR.
- 26 EQUIPMENT HATCH.

NOTE! FOR CLARITY THE AERIAL DRIVING MOTOR IS SHOWN MOUNTED ON THE SIDE OF THE CENTRAL COLUMN OPPOSITE TO ITS NORMAL POSITION.

Fig.2

Radar Type 7 Mk 2. General View

Fig.2

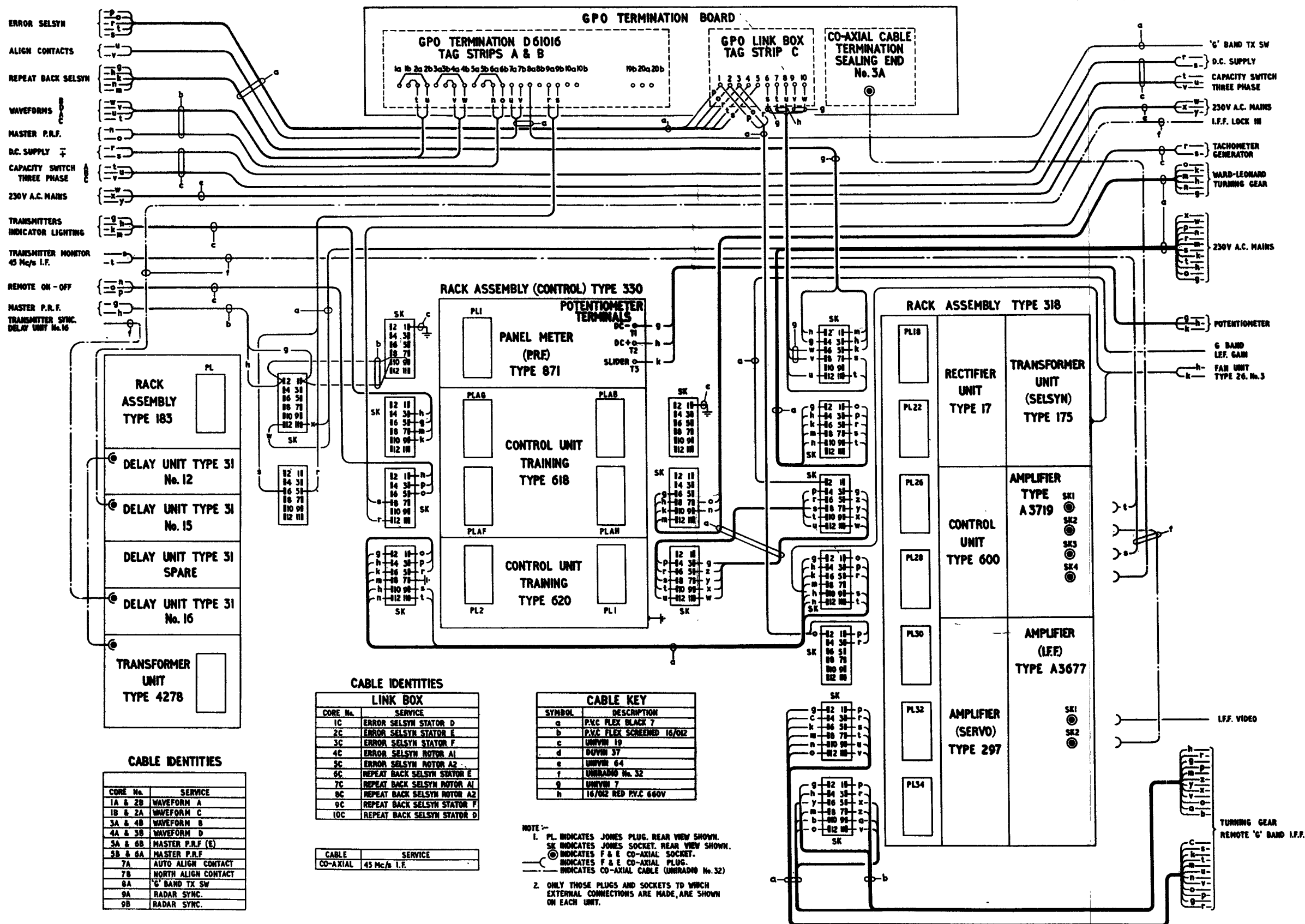


Fig.13.

Radar Type 7 Mk.3 - details of wiring in apparatus compartment

Fig.13.

(AL 12 Jan. 1957)

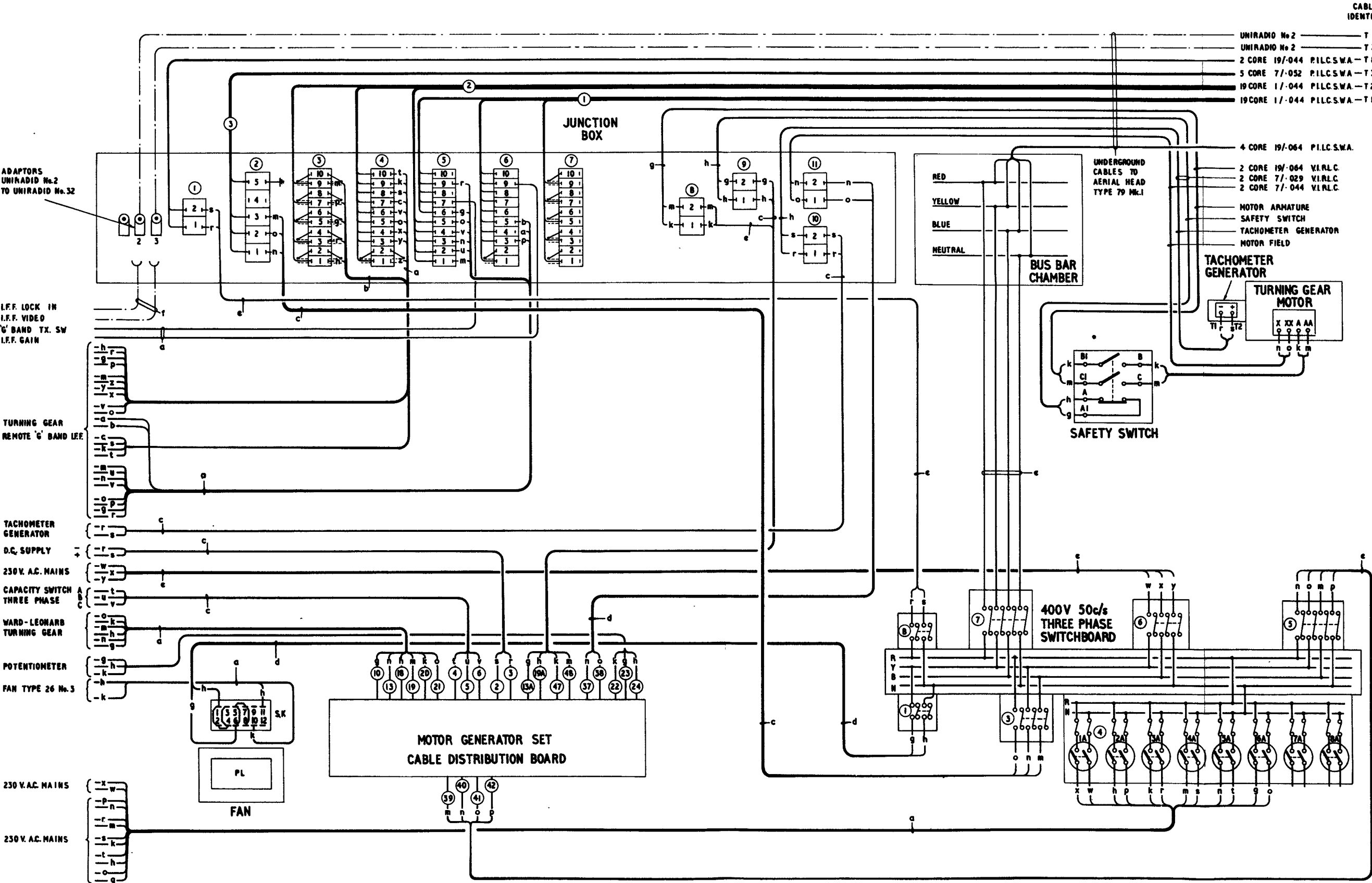


Fig.14

Radar Type 7 Mk. 3 —details of wiring in machine room

CABLE IDENTITIES

JUNCTION BOX-CABLE IDENTITIES

CABLE 1	CABLE 2
CORE No.	CABLE CODE
1	SPARE
2	MINERVA B/GREEN
3	A/GREEN
4	BLACK
5	SPARE
6	SPARE
7	T-9-40
8	T-9-9
9	T-9-12
10	SPARE
11	SPARE
12	SPARE
13	T-9-6
14	SPARE
15	T-9-157
16	T-9-37
17	MINERVA RED
18	T-9-152
19	SPARE

UNIRADIO No.2 T 35
UNIRADIO No.2 T 33
2 CORE 19/044 P.I.L.C.S.W.A.-T 8
5 CORE 7/052 P.I.L.C.S.W.A.-T 3
19 CORE 1/044 P.I.L.C.S.W.A.-T 2
19 CORE 1/044 P.I.L.C.S.W.A.-T 1

4 CORE 19/064 P.I.L.C.S.W.A.
2 CORE 19/064 V.I.R.L.C.
2 CORE 7/029 V.I.R.L.C.
2 CORE 7/044 V.I.R.L.C.

MOTOR ARMATURE
SAFETY SWITCH
TACHOMETER GENERATOR
MOTOR FIELD

UNDERGROUND CABLES TO AERIAL HEAD TYPE 79 Mk.1

TACHOMETER GENERATOR
TURNING GEAR MOTOR

DISTRIBUTION BOARD-CABLE IDENTITIES

BALLOON REFERENCE	SERVICE
1	WARD LEONARD TURNING GEAR-LOWER
2	STOP
3	RAISE COMMON
4	STOP COMMON
5	RAISE
6	START
7	CAPACITY SWITCH THREE PHASE
8	DC SUPPLY
9	TURNING MOTOR ARMATURE
10	SAFETY SWITCH RELAY
11	TURNING MOTOR FIELD
12	POTENTIOMETER SLIDER
13	DC+
14	DC-

CABLE KEY

SYMBOL	DESCRIPTION
a	P.V.C. FLEX. BLACK 7
b	P.V.C. FLEX. SCREENED 16/012
c	UNIVIN 19
d	DUVIN 37
e	UNIVIN 64
f	UNIRADIO No.32
g	2 CORE 19/064 V.I.R.L.C.
h	2 CORE 7/029 V.I.R.L.C.

NOTE

1 PL INDICATES JONES PLUG, REAR VIEW SHOWN
SK INDICATES JONES SOCKET, REAR VIEW SHOWN.
--- INDICATES CO-AXIAL CABLE (UNIRADIO No. 32).
--- INDICATES F & E CO-AXIAL PLUG.

Fig.14

Chapter 2

AERIAL FRAMEWORK AND ACCESSORIES

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Aerial screen ...	5	Slip-ring unit and rotating coupling ...	12

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Introduction

1. The aerials, reflector screen and feeders are fixed to a metal framework which is supported by rollers at the top of a fixed central cylindrical column. The frame measures 54 ft. long $\times$ 25 ft. high $\times$ 5 ft. deep overall, and is rotated by a horizontal chain drive from a DC motor at the foot of the supporting column. The whole assembly is capable of continuous rotation at speeds between 0 and 6 r.p.m.

Central column

2. The fixed hollow cylindrical column is 25 ft. 4 in. high, 3 ft. 7 in. in diameter at the base and 2 ft. in diameter at the top; the column is mounted vertically on a suitable foundation above the top of the transmitter well so that the bottom of the aerial array, when it is in position, is 5 ft. above ground level.

3. The column is made of curved steel sheets welded to form a tapered structure, and is made in two sections which are jointed by bolts through two flanges halfway up the column. The weight of the frame is carried by a tapered roller bearing at the top of the central column. The bottom bearing consists of three pairs of vertical rollers mounted on pins round a flange plate near to the bottom of the column; these rollers bear on the track inside the main sprocket casting at the bottom of the aerial frame. To allow for wear in the rollers, their supporting pins are mounted in eccentric bushes so that the distance of the roller from the centre of the column can be varied to take up wear.

Aerial frame (fig 2)

4. The aerial frame is in the form of an open box 25 ft. high, 30 ft. long and measures 5 ft. from the front to rear. A wedge-shaped extension 8 ft. wide is fixed to each end of the main frame; the extensions carry additional frames which extend the total

width of the framework to 54 ft. The framework is constructed of steel throughout, mainly of angle section. The main framework is similar to that originally used for the AMES Type 7 stations, suitably strengthened to carry the extensions.

Aerial screen

5. Two separate aerial screens are provided, one for the bottom and middle arrays and one for the top array. Each screen is made up of a number of panels of 3 in. $\times$ 1 in. steel mesh, the mesh being fixed so that the horizontal wires are one inch apart. The two screens, which are of the same size, measure 54 ft. $\times$ 11 ft., they are mounted on the front of the frame, one above the other, with a space of 3 ft. between the top of the lower screen and the bottom of the upper screen. The panels which make up the screens are carefully bonded together and to earth.

Capacity switch cubicle

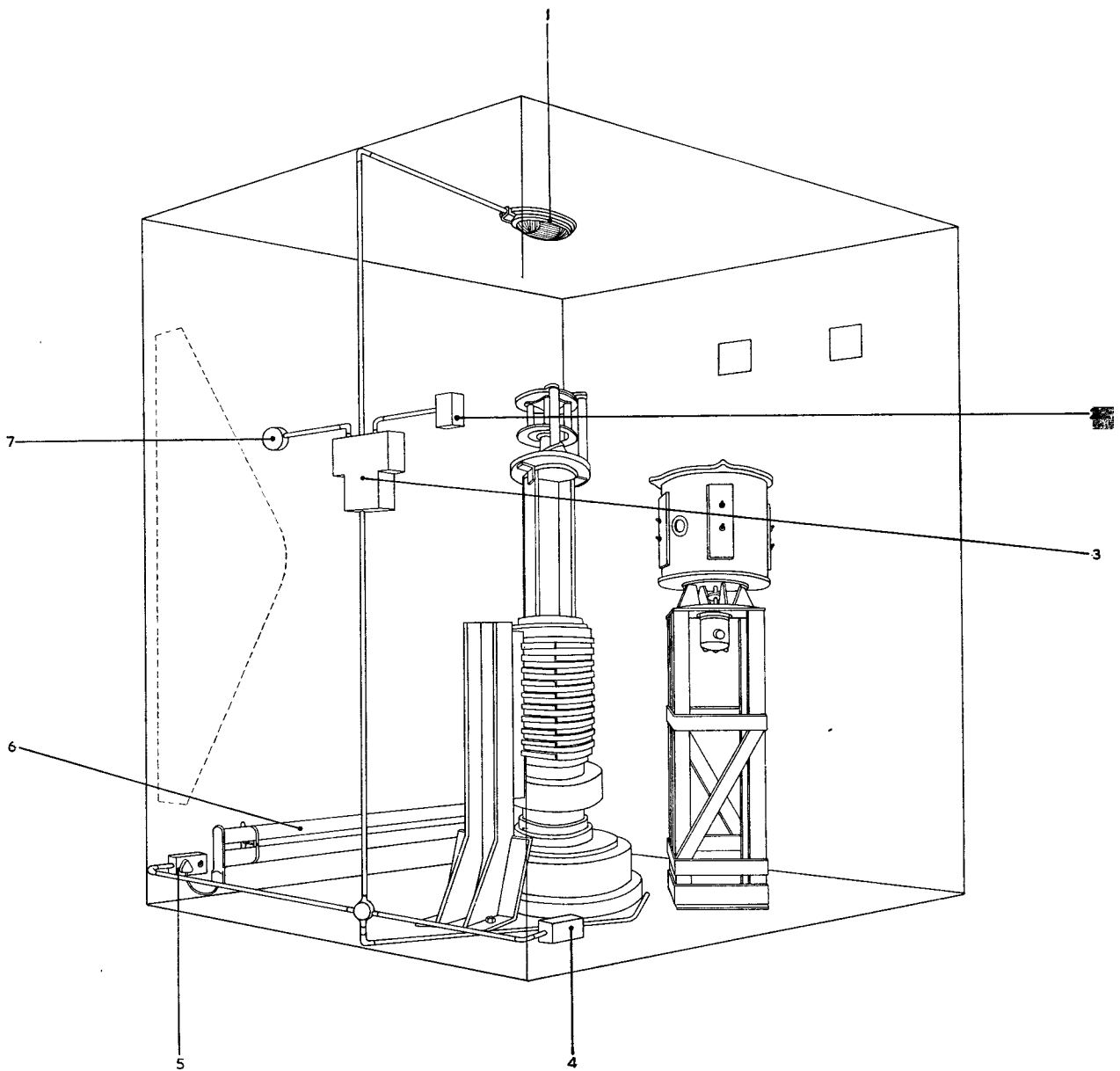
6. A small closed cubicle approximately 6 ft. 6 in. high and 5 ft. square is situated directly above the central column and forms part of the aerial framework. This cubicle houses the capacity switch and its associated feeder network, the rotating coupling joint for the aerial feeder, and slip-rings for feeding various circuits in the cubicle.

7. A steel ladder inside the frame gives access to a small platform at the side of the capacity switch cubicle and a door in the side of the cubicle enables the equipment inside to be reached for servicing purposes.

Selsyns

8. Two selsyn transmitters driven from the aerial framework through a chain drive are mounted at the top of the column under the capacity switch cubicle. These transmitters supply information on

(A.L.4, Jan. 56)



KEY.

- | | |
|------------------------------|-----------------------------|
| 1 BULKHEAD LIGHT FITTING. | 5 5A POWER POINT FOR HEATER |
| 2 THERMOSTAT | 6. 480W TUBULAR HEATER. |
| 3. SWITCH & DISTRIBUTION BOX | 7 LIGHT SWITCH |
| 4 5A POWER POINT | |

Fig. 1. Layout of electrical equipment in capacity switch cubicle

the position of the aerial array for the following purposes:—

(1) Driving the PPI consoles in the operations centre. (Repeat-back selsyn).

(2) Driving the aerials of other radar equipments on the same site in synchronism with the radar 7 aerial array. (Error selsyn).

Auto-align and head line contacts are provided; these are mounted on the shaft which drives the error selsyn.

9. The drive between the aerial frame and the selsyns is by a $\frac{1}{2}$ in. roller chain from a chain wheel attached to the underside of the floor of the capacity switch cubicle. The chain drives two sprockets which drive the selsyns through spur gears, the chain being kept taut by a jockey sprocket tensioned by a spring. The spindles of the selsyn intermediate drive are fitted with oilite bearings—these do not require lubrication but should be changed every two or three years. A platform on the main framework allows the selsyns to be reached for servicing purposes.

Turning mechanism

10. The aerial framework is rotated around the fixed central pillar by a 16 h.p. DC motor fed from the output of a Ward-Leonard generator set. The motor drives a Radicon worm gearbox with a reduction ratio of 19.5:1. The gearbox is totally enclosed and is filled with oil compound OC-338, its capacity being 2 gallons. A dip stick is provided on the side of the gearbox for checking the oil level. A 19-tooth sprocket is fitted on the vertical output shaft of the gearbox, which drives a chain wheel fixed to the main frame, through a horizontal roller chain drive. The number of teeth on the chain wheel is 124 which gives a total reduction from motor to frame of approximately 127:1. The chain is kept taut by a jockey sprocket which is mounted on a pillar which has its base fixed in a slide so that it can be moved to take up slackness in the chain. The lower bearing rollers (*para.* 3) run around the inside of this chain wheel. Mounted on a panel on the side of the column is a battery of grease nipples which are connected to the bearing rollers and to the bearings on the gearbox by means of flexible pipes. This is to facilitate maintenance. The lubricator

for the jockey sprocket is not fed from this battery, but is mounted on the top of the sprocket.

11. A small tachometer-generator on the end of the aerial driving motor gives a voltage output proportional to the speed of rotation of the aerial frame; the tachometer-generator feeds a voltmeter calibrated to read in aerial r.p.m., fitted in the control unit (training) Type 618 in the transmitter well (Mk. 3 installations) or radar office (Mk. 2 installations).

Slip-ring unit and rotating coupling

12. Conduits are welded inside the central column to carry the cables up to the capacity switch cubicle, and the selsyns, the conduits running up the inside of the column from a junction box on the ceiling of the transmitter well. The tensioned aerial feeder runs up centrally inside the column. The slip-ring unit inside the capacity switch cubicle has 20 slip-rings, each with two $\frac{3}{8}$ in. $\times$ 1 in. metal graphite brushes (10BB/2386) which are capable of carrying a current of 15A at 250V. The slip-rings are tested at 2 kV AC. The rings carry various supplies to and from the cubicle; details of the slip-ring connections are given in Table 1.

TABLE I
Details of slip-ring connections

Slip-ring No.	Supply	In well	Connections In cubicle
1	Common negative lead for capacity switch alternator fields	Capacity switch control panel	Capacity switch
2	Positive of field supply to MSW alternator (PRF)	Capacity switch control panel	Capacity switch
3	Master sine-wave alternator output	Phasing unit ($\frac{1}{4}$ PRF) Type 30 or 100	Capacity switch
4	$\frac{1}{4}$ PRF alternator outputs $\left\{ \begin{array}{l} A \\ B \\ C \\ D \end{array} \right.$	Phasing unit ($\frac{1}{4}$ PRF) Type 30 or 100	Capacity switch
5			
6			
7			
8	Positive of field supply to $\frac{1}{4}$ PRF alternator	Capacity switch control panel	Capacity switch
9			
10	Spare		
11	3-phase supply, 15-30 c/s for capacity switch motor	Capacity switch control panel	Capacity switch
12			
13			
14	Spare		
15	Telephone	Station telephone system	Telephone
16			
17	Spare		
18	230V AC lighting and heating circuit in	Line 230V AC distribution Neut. board in transmitter compartment	Lighting and power splitter
19	cubicle		
20	Earth		

13. The rotating feeder coupling is mounted above the slip-ring assembly. This coupling forms a rotating joint between the stationary feeder from the well and the feeder system to the aerial arrays.

14. The lighting and heating circuits brought into the cubicle (*fig.* 1) are taken to a 230V 5A fuse and distribution box, fitted with an isolating switch, on the cubicle wall. The box feeds three separate circuits, a bulkhead light controlled by a tumbler

switch on the wall, a 5-amp. wall socket feeding a two-bank tubular heater and a 5-amp. switched wall socket for maintenance purposes. The tubular heater is mounted along one side of the cubicle near the floor and is rated at 480W. The circuit to the socket which feeds it is taken via a thermostat unit which is set to switch off the supply to the heater when the cubicle temperature reaches 60 deg.F. (15.5 deg. C.). All mains wiring inside the cubicle is run inside galvanized conduit.



Connections Between Transmitter Well and

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Chapter 3

TURNING GEAR AND CAPACITY SWITCH DRIVING EQUIPMENT

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WARD-LEONARD CONTROL GEAR

General

1. The aerial frame is driven by a DC motor the speed of which is controlled by the Ward-Leonard system, a simplified circuit of which is shown in fig. 1. This system is one in which a DC generator is run at constant speed by a prime mover (in this

instance a three-phase AC motor) and the field current of the generator is varied to control the output voltage. The generator output is fed to the armature of the variable speed aerial motor, which is also supplied with a steady field current. The speed of rotation of the aerial frame is thus controlled by the excitation of the generator and the system acts as a power amplifier.

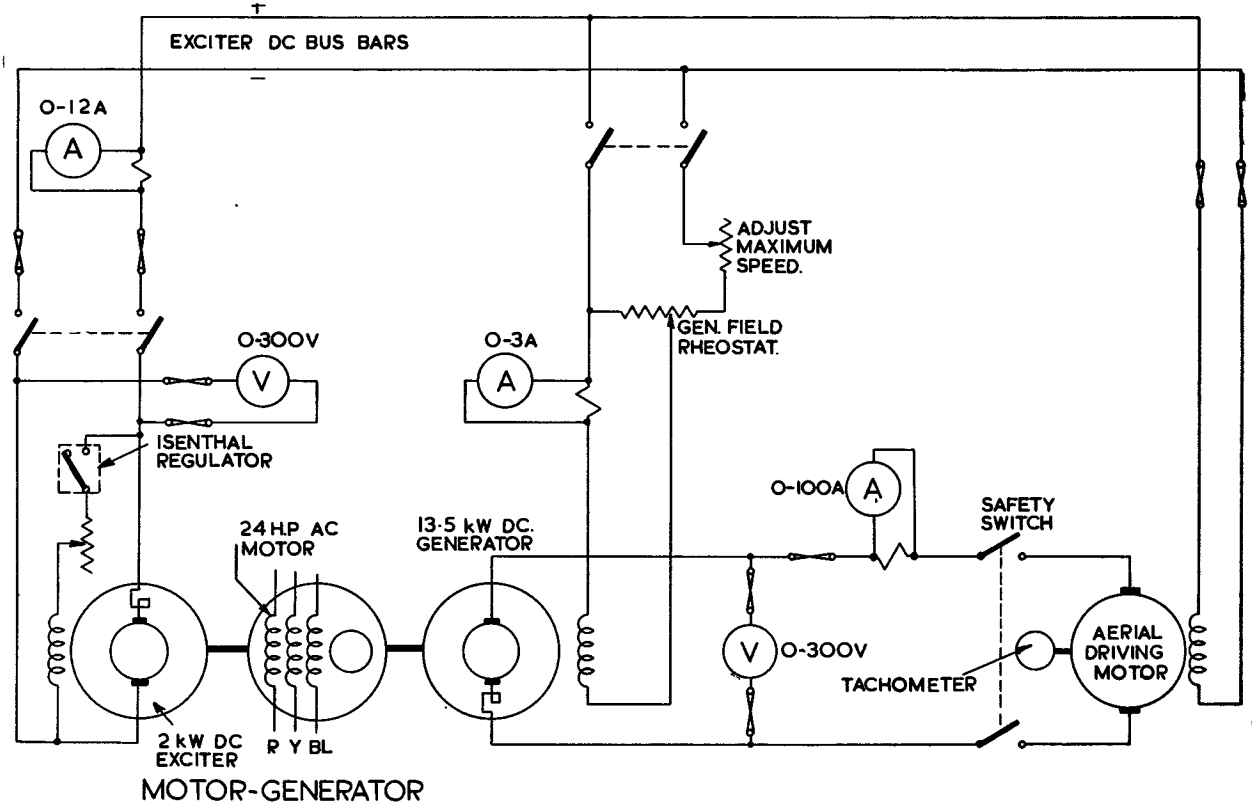


Fig. 1. Simplified circuit of Ward-Leonard system

C1 & C2 CLOSE FOR STARTING
C1 & C3 CLOSE FOR RUNNING
C2 & C3 ARE INTERLOCKED SO
THAT ONLY ONE CAN BE CLOSED
AT A TIME.

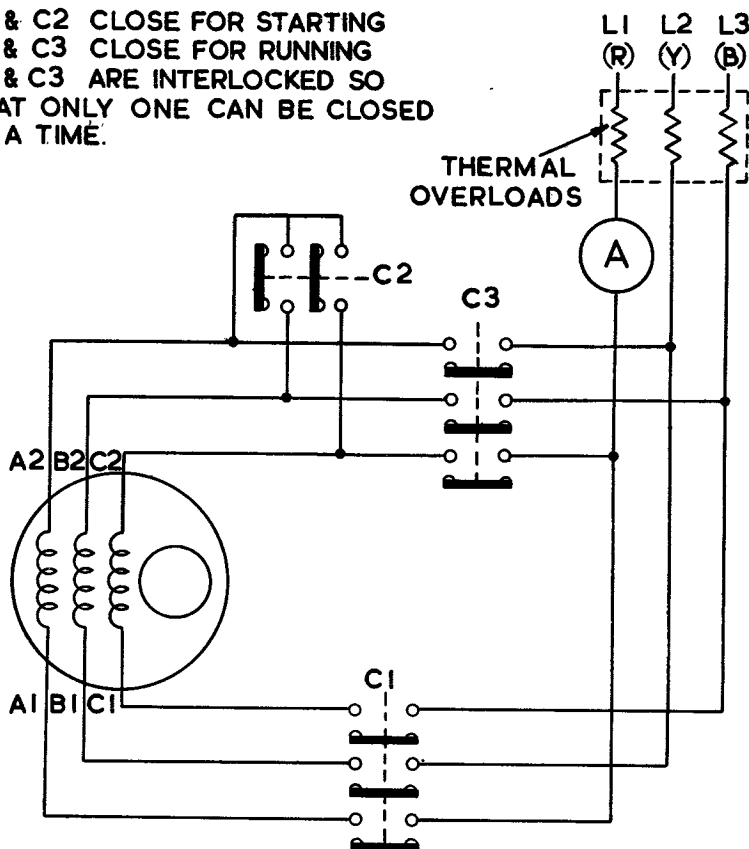


Fig. 2. Motor-generator starting circuit

2. The steady DC voltage for supplying the field current of the aerial driving motor (*Sect. 2, Chap. 1*) is provided by an exciter, also driven by the AC motor. The exciter also supplies the field current for the DC generator through preset and variable

rheostats; these control the output of the generator and hence the speed of the aerial motor. The speed of rotation of the aerial system may be varied between zero and 6 r.p.m.

Ward-Leonard motor-generator set (fig. 5)

3. The motor-generator set (motor-generator Type 81) together with its starting and control equipment, is located:—

- (1) On radar 7 Mk. 2 installations, in the station machine room in the operations block.
- (2) On radar 7 Mk. 3 installations, in the transmitter well machine room.

The motor generator consists of three machines mounted on a common frame, these three machines being:—

- (a) A 24HP 400V three phase squirrel cage motor.
- (b) A 13.5kV 230V DC generator.
- (c) A 2kW 230V DC exciter.

4. The output voltage of the DC generator is variable while the output of the DC exciter is controlled by a voltage regulator of the Isenthal type (*para. 6*).

Motor generator starter (fig. 5)

5. The motor generator is controlled by a remotely-controlled airbreak starter working on the star-delta principle. This starter is mounted on the wall of the machine room near to the motor generator.

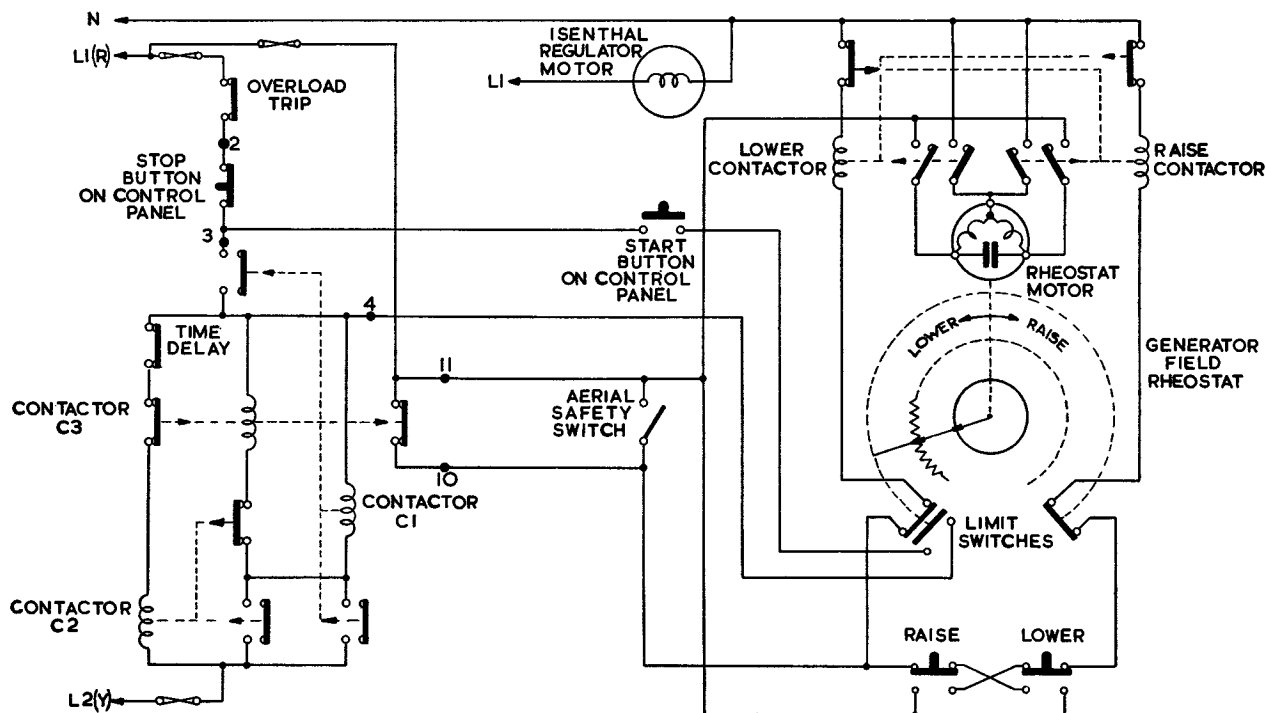


Fig. 3. Starter interlocks and speed-control circuit

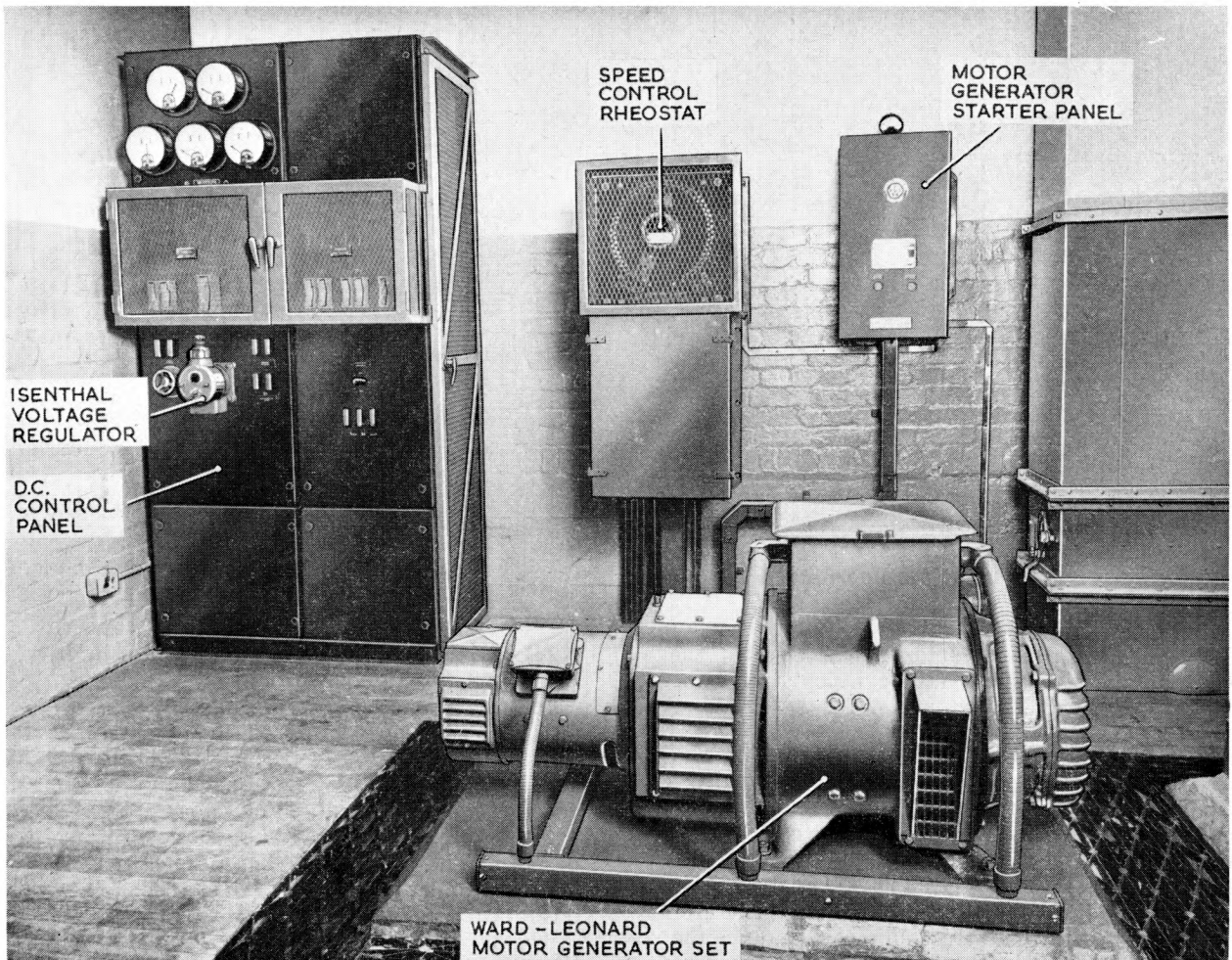


Fig. 5. Ward-Leonard equipment in operations block machine room

DC control panel and speed control rheostat (fig. 5)

6. The contactors, switches, fuses, meters and the Isenthal regulator are mounted on the DC control panel which is mounted on the floor of the machine room or transmitter well adjacent to the motor generator set. The circuit diagram of the DC control panel is included in the overall diagram (fig. 4 at end of chapter). Details of the Isenthal type of voltage regulator will be found in Air Publication 1095G.

7. The motor driven rheostat is mounted in a cabinet on the wall of the compartment. This cabinet also houses a distribution box for inter-connections between units of the turning gear system.

8. The rheostat motor is controlled by "raise" and "lower" contactors, operated by push buttons in the radar office (Mk. 2 installations) or the well apparatus compartment (Mk. 3 installations). A series limiting resistor on the DC control panel enables the maximum generator field current to be set to give a maximum aerial speed of 6 r.p.m.

9. Referring to the circuit shown in fig. 2 the motor-generator is started by the remotely control-

led starter. The starter consists of three sets of contactors, C1, C2 and C3 which are electrically and mechanically interlocked to give sequential operation. Thus, when the start button (fig. 3) is pressed, contactor C2 closes and is followed by C1. These connect the motor winding in star. A time-delay relay (started by contactor C2) opens eight seconds later, when the starting current has died away, so that contactor C2 opens and allows C3 to close, connecting the motor windings in delta. Contactors C2 and C3 are mechanically inter-locked so that both cannot be closed at the same time. Where circuits are numbered on the equipment, these numbers are shown on the circuit diagram.

10. In greater detail, the operation of the motor-generator set may be described as follows. In the STOP condition, with all the starting contactors de-energized, one phase, L1, is connected to neutral via:—

- (1) auxiliary break contacts 10–11 on C3,
- (2) break contacts on the motor operated rheostat LOWER LIMIT switch and,
- (3) the operating winding of the "lower" contactor.

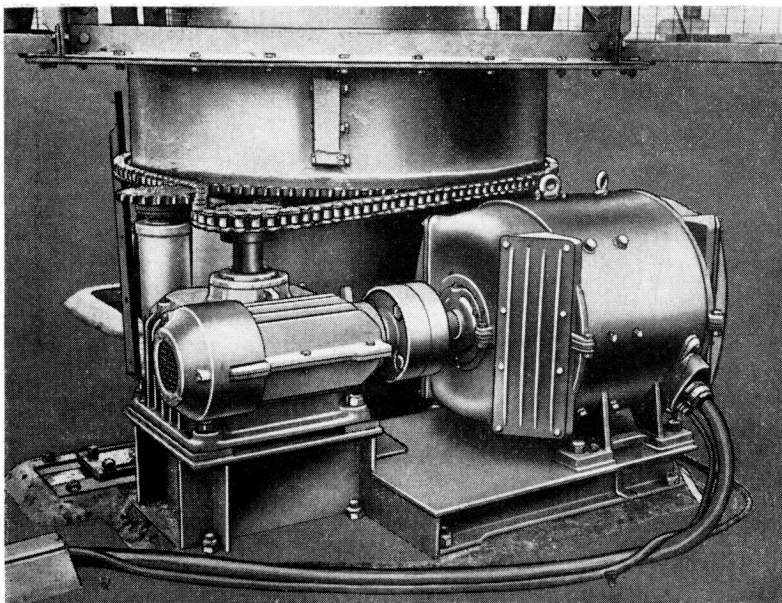


Fig. 6. Turning motor and drive

This operates the contactor and completes the circuit for the rheostat motor which drives the rheostat down.

11. On reaching its zero position the moving arm of the rheostat operates the limit switch, de-energizing the "lower" contactor so that the motor stops. Make contacts on the limit switch complete the circuit to the START button so that the generator set can be started. When the START button is pressed it should be noted that the motor generator can only be started with minimum load on the generator, that is, with the rheostat in the zero position.

12. When the START push-button, in the radar office or remote well, is pressed, the circuit for the operation of C2 is completed to the second phase L2 via:—

- (1) the thermal overload trip contact 1-2.
- (2) back contacts on the STOP push-button,
- (3) the START button,
- (4) the LOWER limit switch on the rheostat (*para. 7*),
- (5) the contactor C1 time-delay contact 4-6, and
- (6) an auxiliary break contact 8-9 on contactor C3.

Contactor C2 closes and connects the three stator windings on the AC motor in star by short-circuiting the connections to the terminals labelled B2, A2 and c2 ready for the application of AC. The designation c2 is sign-written alongside the terminals and is not likely to be confused with the similar annotation of contactor C2.

13. At the same time:—

- (1) The auxiliary contact 7-8 on contactor C2 opens to prevent contactor C3 being energized
- (2) the auxiliary contact 5-7 closes to operate contactor C1, which closes

(3) Contact 3-4 on C1 short-circuits the START push-button circuit, which can now be released

(4) the main contacts on C1 apply three-phase AC to the motor, which starts

(5) auxiliary contact 5-7 on C1 short-circuits the contacts of C2 which operated C1 so that C1 will still hold when C2 releases.

14. After a period of *eight seconds*, the motor starting current has fallen to a safe value and at this point:—

(1) the time-delay relay contacts 4-6 associated with contactor C2 open and break the operating circuit for C2

(2) C2 releases and, immediately,

(3) C3 operates due to contacts 7-8 of C2 completing the operating circuit

(4) Contacts on C3 connect the motor in delta, its normal operating condition

(5) Auxiliary contacts 6-9 on C3 prevent C2 operating whilst C3 is closed.

15. The load can now be applied to the motor-generator, so contacts 10-11 on C3 break the circuit which automatically drove the rheostat to the zero position. The rheostat driving motor is now automatically under the control of the RAISE and LOWER push-buttons.

16. To stop the aerial motor and generator set, the STOP push-button must be pressed. This breaks the supply to the starter contactors which then release. When C3 releases, it completes the circuit to the rheostat driving motor which drives the rheostat to its zero position (*para. 10*).

Control unit Type 618

17. The control unit Type 618 which is fully described in Air Publication 2886H is mounted in a rack assembly (control) situated either in the radar office or in the remote well. It has four push-buttons labelled START, STOP, RAISE and LOWER. The RAISE and LOWER buttons control the speed of rotation of the aerial by operating the rheostat driving motor via the "raise" and "lower" contactors. When changing speed, it is necessary for the appropriate push-button to be pressed and held in position until the desired speed is reached.

18. Closing the RAISE or LOWER buttons energizes the appropriate contactor on the main DC panel, the contacts completing the motor circuit and causing it to turn in the required direction. As soon as the button is released the circuit is broken and the motor stops so that the rheostat remains stationary in its new position. The RAISE and LOWER buttons and the "raise" and "lower" contactors are electrically interlocked so that no damage will result if the two buttons are pressed simultaneously.

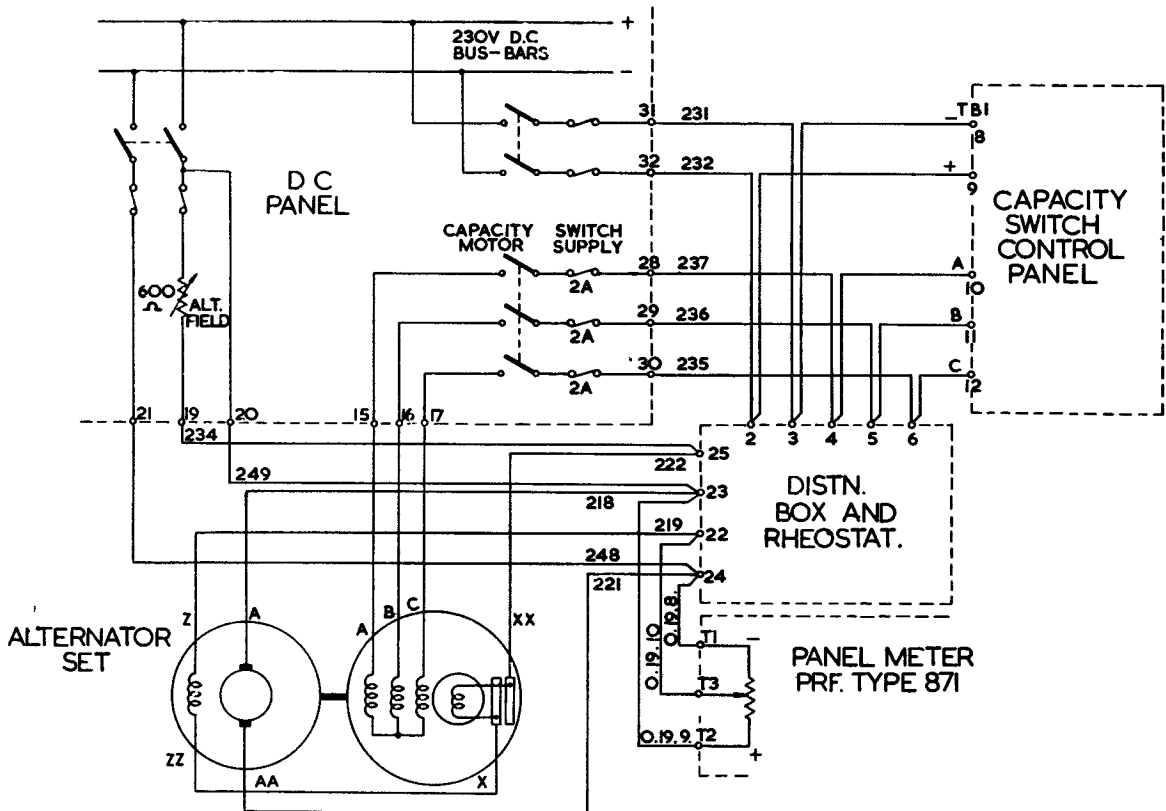


Fig. 7. Connections to capacity switch alternator

19. The aerial takes fifteen seconds from the rest condition to reach a speed of six r.p.m. and it may be stopped by pressing the STOP button which stops the motor generator set and returns the generator field rheostat to the zero position. Overloads will operate the thermal overload trip, which is connected in series with the STOP button and so stops the generator set. Failure of supplies opens all contactors; when the supply is reconnected the motor generator will not start and the generator rheostat will be driven to the zero position.

20. Protection for the system is, therefore, effected by:—

- (1) The motor-generator set can only be started if the rheostat is in the zero position.
- (2) If an abnormal load is put on the motor-generator, the overload trip will operate.
- (3) If the motor-generator set is stopped, or if the safety switch on the aerial frame is put to OFF, the rheostat will automatically return to the zero position.

CAPACITY SWITCH DRIVING EQUIPMENT

Alternator set

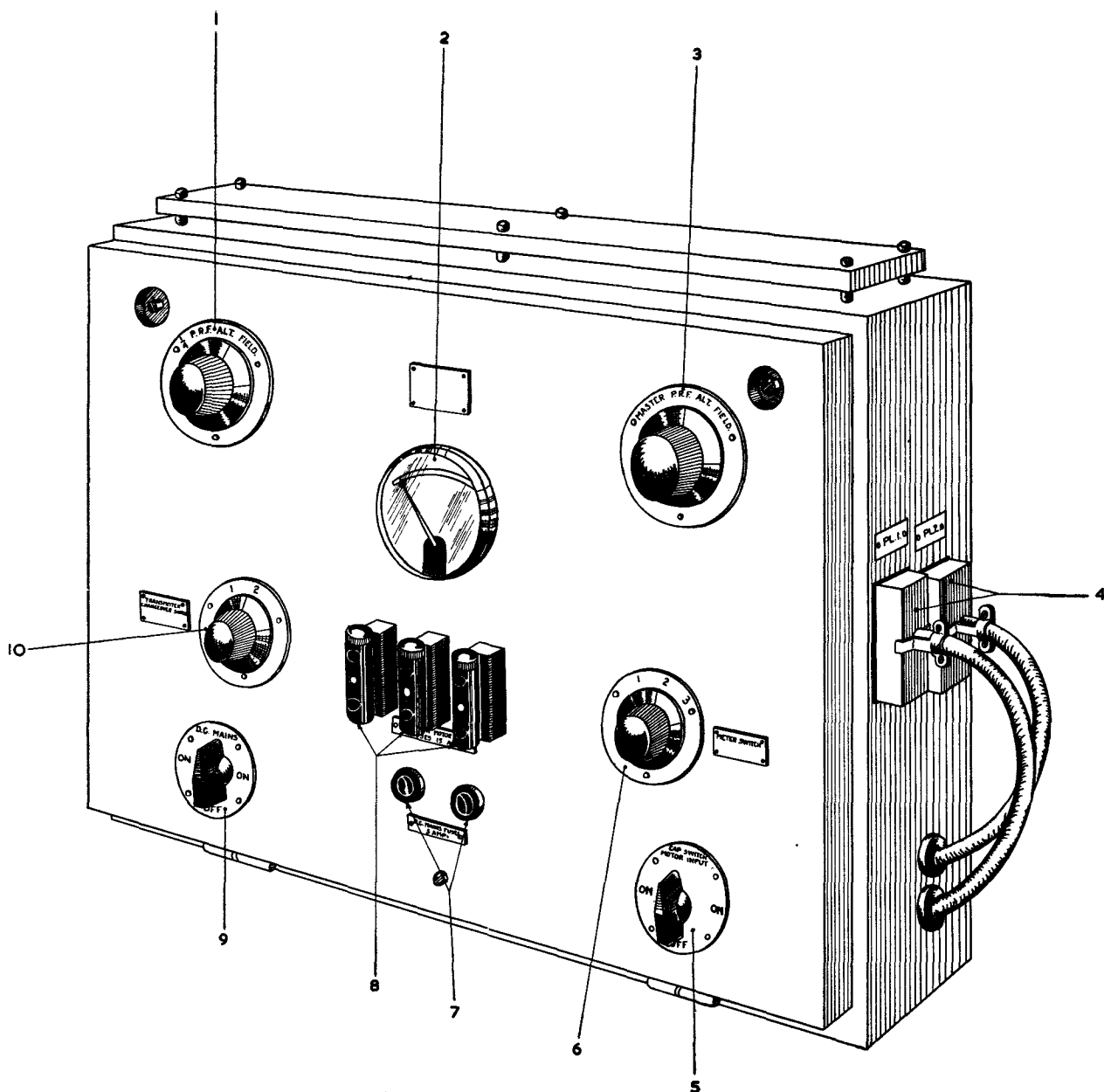
21. The alternator set which generates the three-phase supply for the capacity switch driving motor is housed in the same room as the Ward-Leonard motor generator, that is, the station machine room in radar Type 7 Mk. 2 installations and the transmitter well machine room in the radar Type 7 Mk. 3 installations.

22. The driving motor of the alternator set is connected across the DC exciter output of the Ward-Leonard control equipment and starts automatically when the aerial turning gear is switched on.

23. The alternator set consists of a 230V DC shunt-wound motor running at a speed of between 900 and 1,800 r.p.m., depending on its field current, and driving a three-phase alternator rated at 27–50 c/s, 1,620–3,000 r.p.m. 277–420V AC, with an output of 0.27–0.5kVA, and a power factor of 0.75. The speed of the driving motor is such that the alternator output frequency is variable between 15 and 30 c/s; the frequency is normally maintained at approximately 24 c/s (a motor speed of 1,250 r.p.m.) the actual speed being determined by the output frequency of the master sine wave alternator on the capacity switch which should be maintained at 250 c/s.

24. The alternator set is essentially the same type as that originally used for driving the capacity switch at AMES Type 7 stations. In the present application however, the motor is rewound to run at the lower speed instead of the original 1,620–3,000 r.p.m. and the nomenclature of the unit has been changed from the alternator unit Type 3 to alternator unit Type 3A. Two controls are associated with the alternator set, the connections to which are shown in fig. 7. The first, the motor field rheostat, is mounted on the back of the panel, meter (PRF) Type 871 and is controlled by a knob on the front of the panel; this control affects the

(A.L.4, Jan. 56)



KEY

- | | |
|--|------------------------------------|
| 1 $\frac{1}{4}$ PRF ALTERNATOR FIELD CONTROL | 6 METER SWITCH |
| 2 METER | 7 DC MAINS FUSES |
| 3 M.S.W. ALTERNATOR FIELD CONTROL | 8 AC FUSES (CAPACITY SWITCH MOTOR) |
| 4 INTERLOCK SOCKETS | 9 DC MAINS SWITCH |
| 5 CAPACITY-SWITCH MOTOR SWITCH | 10 TRANSMITTER CHANGEOVER SWITCH |

Fig. 8. Control panel (capacity switch) Type 869—general view

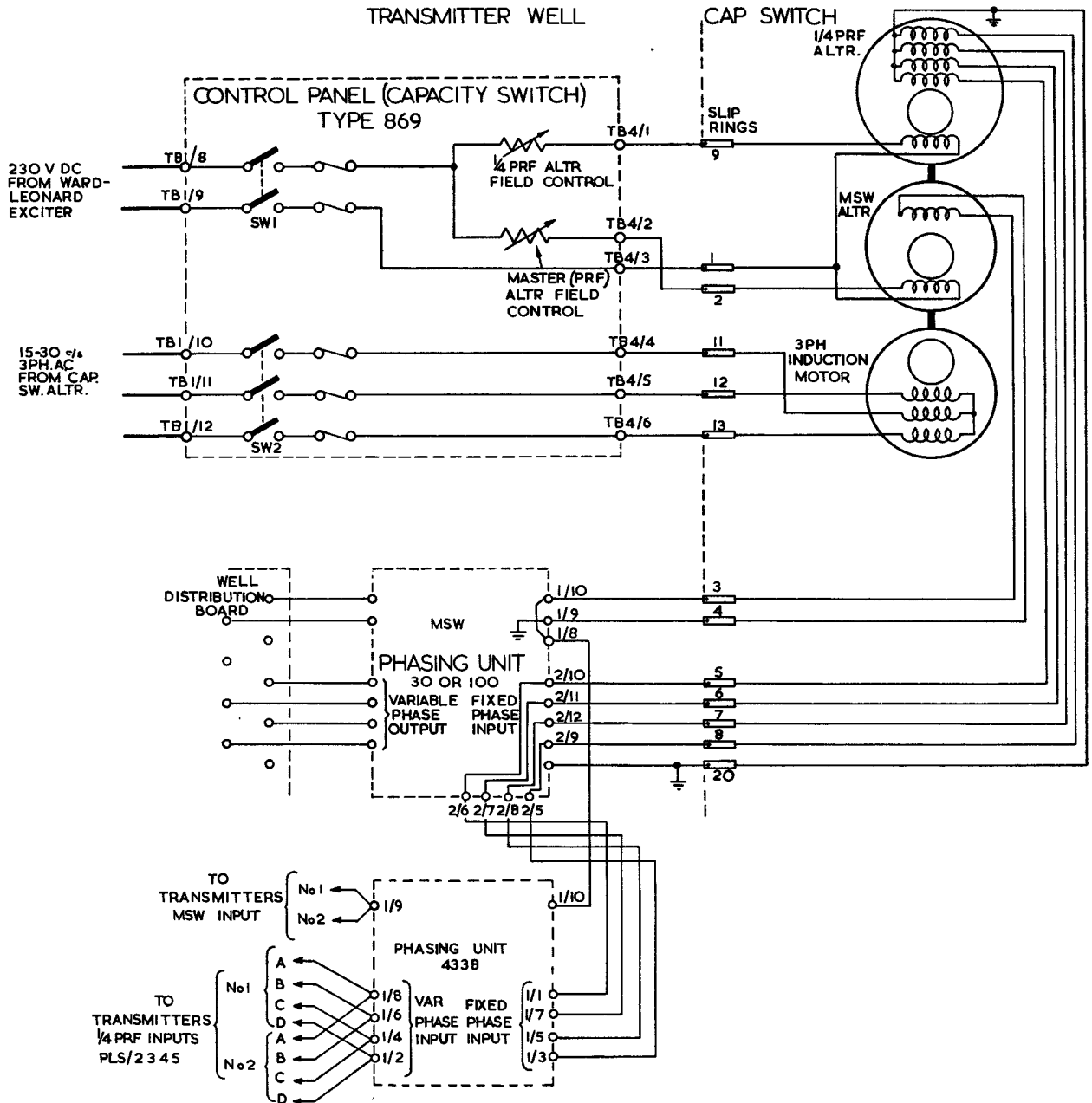


Fig. 9. Explanatory diagram of supplies to capacity switch

frequency of the alternator output and hence the pulse recurrence frequency. The second control is on the DC control board associated with the Ward-Leonard equipment and controls the field of the alternator and hence its output voltage.

Capacity switch control panel

25. Control panel (capacity switch) Type 869 (*fig. 8*) is mounted on the wall of the transmitter well in the same compartment as the transmitters. The panel consists of a steel cabinet 22 in. high, 29½ in. wide and 8 in. deep with four brackets on the rear for securing it to the wall. The front panel of the cabinet is hinged at the bottom and held closed by

two captive screws at the top, the controls protruding through holes in the front panel when it is closed. Connections to external units are made to tag-blocks (*fig. 10*); the connections which bring DC and AC supplies into the unit are taken from these tag-blocks to the unit proper via two 10-pin Jones sockets, connected to the tag-blocks with short lengths of cable, which mate with plugs on the side of the cabinet. A bracket fitted to the side of the front panel, has apertures into which these sockets fit when they are plugged into position. Thus the sockets must be removed before the front panel can be opened; this breaks the circuit and removes supplies from the unit.

26. The unit provides facilities for controlling the field current of the two alternators in the capacity switch and switching of the two supplies to it. It also provides facilities for changing over the connections from the control and synchronizing pulse circuits to the transmitters. A meter (0–300V DC) and switch are provided for metering the DC input and the voltages to the two field windings.

27. The controls are as follows:—

- | | |
|--|---|
| (1) DC MAINS
(SW1) | On-off switch for 230V DC supply to potentiometers controlling field current to alternators in capacity switch. |
| (2) Cap switch
Motor input
(SW2) | On-off switch for 3-phase supply to capacity switch motor. |
| (3) Meter switch
(SW3) | Switch meter (0–300V DC) to read:—
(1) $\frac{1}{4}$ PRF alternator field voltage |

(2) Master sine alternator field voltage

(3) DC input voltage to panel

(4) Transmitter changeover (SW4) Connects control circuits and synchronizing circuits to the transmitter which is to be used. Switches Receiver monitor output from amplifier Type A.3719 to transmitter in use.

(5) $\frac{1}{4}$ PRF ALT. FIELD (RV1) Controls field current of alternator in capacity switch generating four sine waves at $\frac{1}{4}$ p.r.f.

(6) MASTER PRF ALT. FIELD (RV2) Controls field current of alternator in capacity switch generating sine wave at p.r.f.

28. Connections between the supplies and the capacity switch are shown in fig. 9.

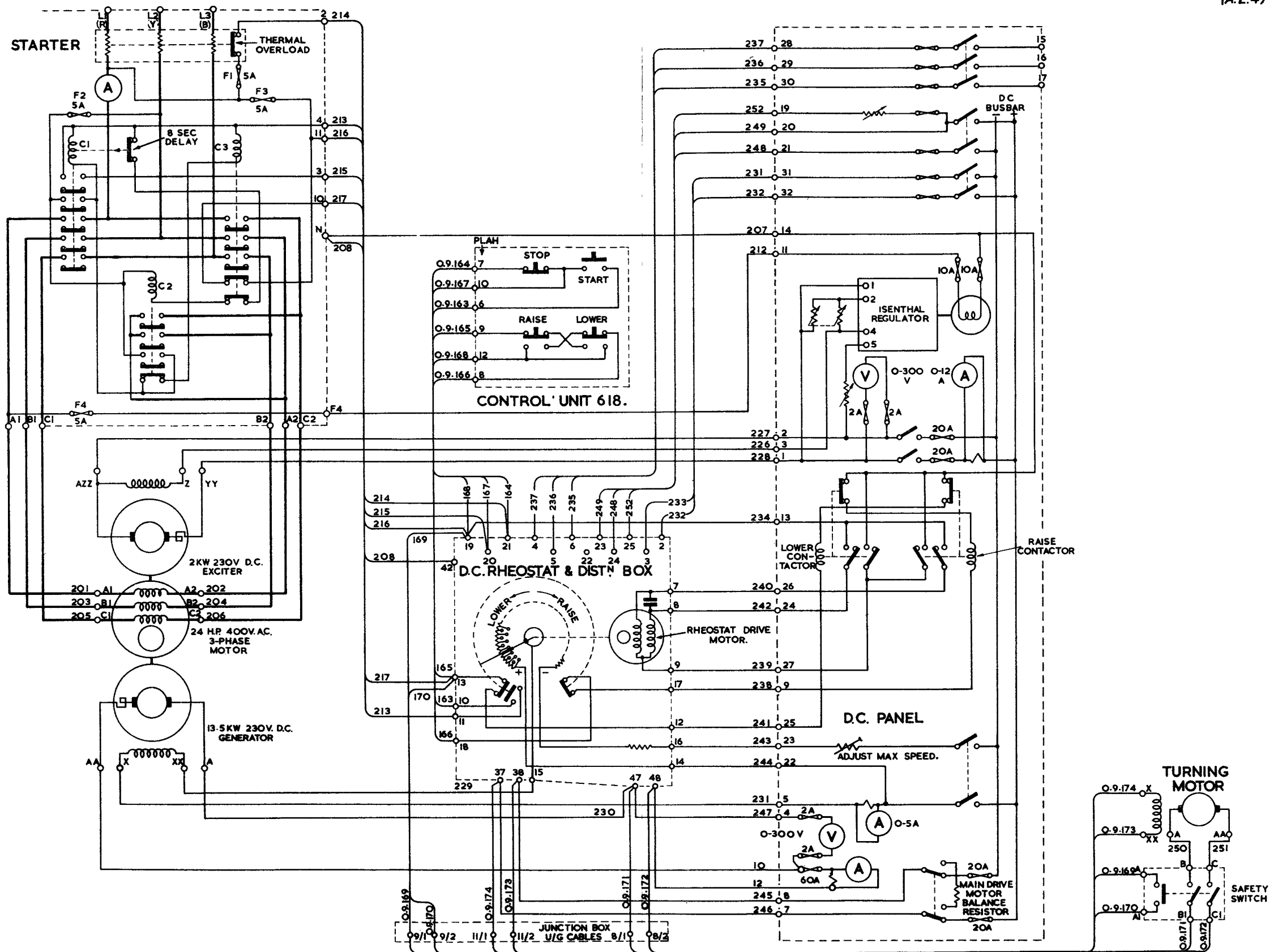


Fig. 4

Ward - Leonard Control Gear Circuit.

Fig.4

(AL4 Jan 56)

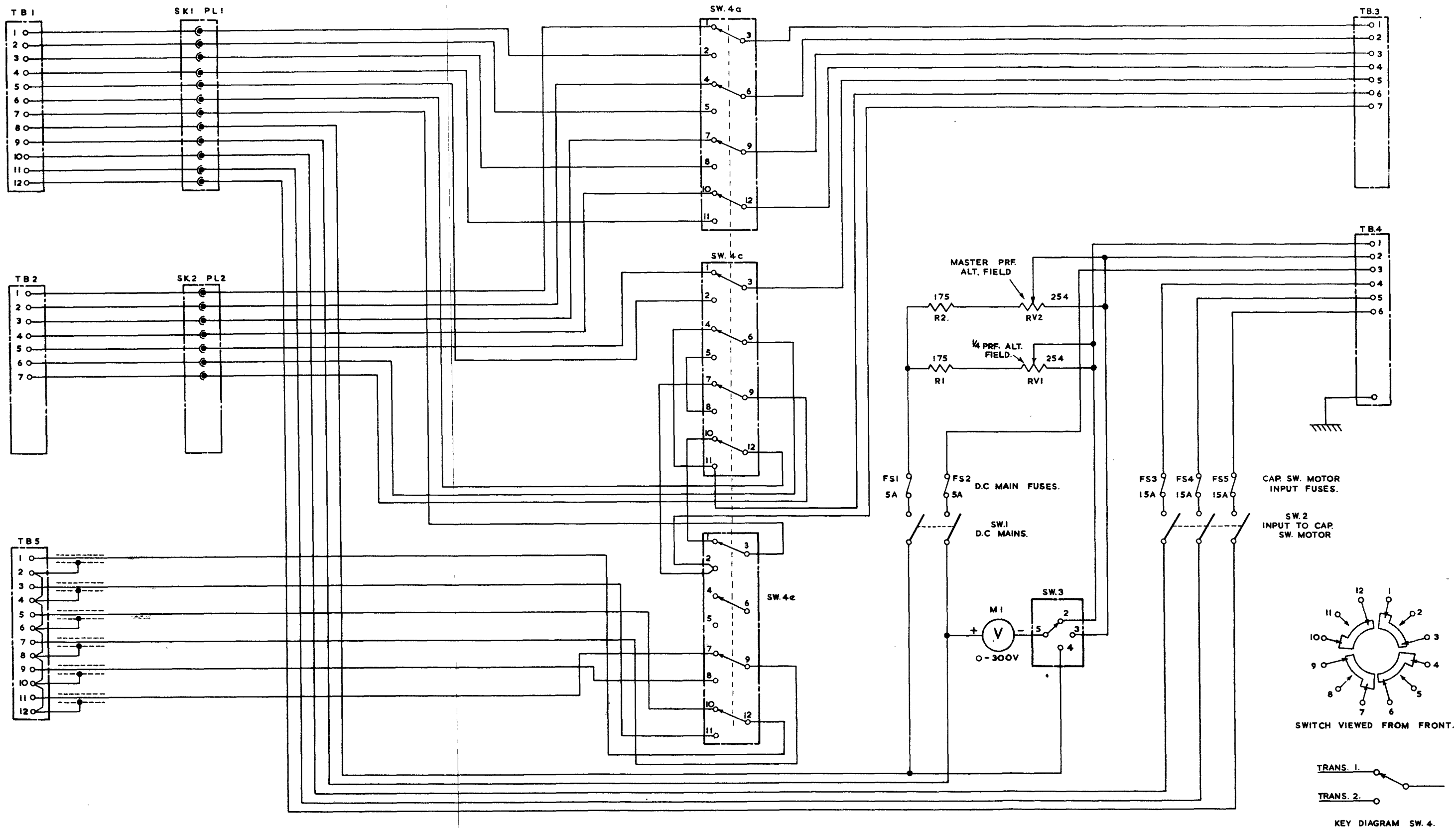


Fig. 10

Control panel (capacity switch) Type 869 - circuit

Fig. 10

(AL. 4 Jan. 56)

Chapter I

TRANSMITTER TYPE T.3705

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Note.—Fig. 29 to 36 (incl.) are available as miniature A.D's in Series AD6236 MIN.

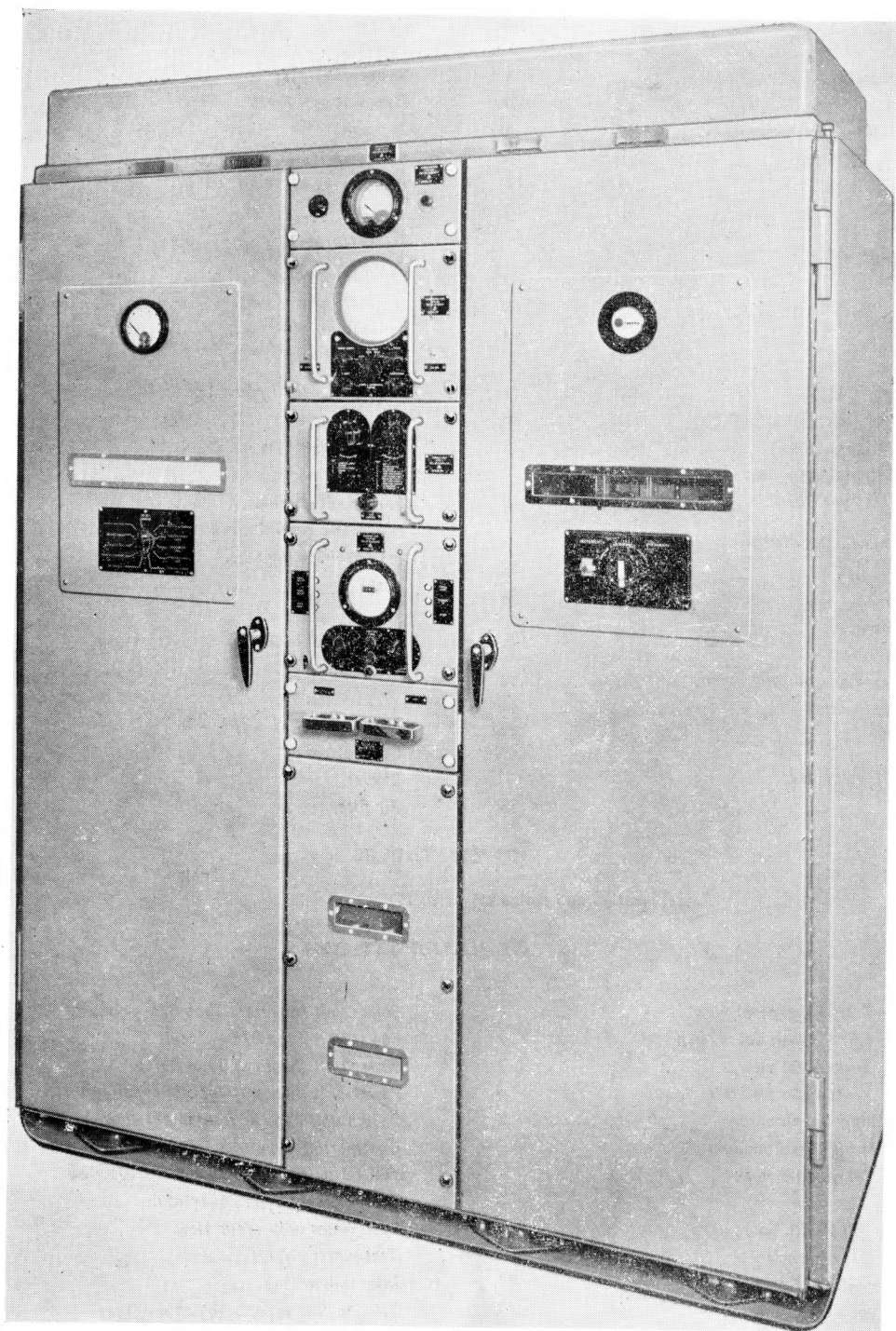


Fig. 1. Transmitter Type T.3705—general view

General

1. The transmitter Type T.3705 is a radar transmitter which operates on any desired frequency in the band 185 – 215 Mc/s and generates a pulse of $3.6\mu\text{s}$ duration at a peak power output variable between 50 and 450kW approximately. The pulse recurrence frequency is variable between 250 and 550 c/s, the maximum average power output being approximately 1.6kW. The transmitter is fully automatic and is controlled by two push buttons, one for switching on and one for switching off. The time taken for the transmitter to run up to full power varies between 250 and 350 seconds. Built-in metering and monitoring facilities are provided on the transmitter for all important supplies and waveforms. The transmitter operates from a 225 to 245V 45 – 65 c/s single-phase supply and its loading is about 5kVA at 60 c/s. The transmitter is practically identical in design and construction with the T.3692 (Air Publication 2912K).

2. The transmitter is housed in a cabinet 5 ft. wide, 6 ft. 6 in. high and 2 ft. $7\frac{1}{2}$ in. deep from front to back. The cabinet is divided vertically into three compartments, and is fitted with doors which cover the right- and left-hand compartments, but not the centre compartment. When the transmitter doors are open they extend from the front of the transmitter by a further 1 ft. 8 in. The door on the right-hand side of the cabinet covers the RF and high power modulator compartment. The RF oscillator is mounted on the back of this door inside screened compartments. In the rear of the right-hand compartment there are mounted the pulse-forming network, the pulse transformer, a power supply unit for feeding the heaters of the oscillator and the output feeder from the oscillator to the terminals on the top of the cabinet. In the left-hand compartment there are the main HT power supply unit (with the exception of the main HT capacitor), the charging reactor, hold-off and overswing diodes and the auxiliary power supply units. In the centre compartment, which is not covered by the doors, there are the kV meter panel, monitor unit, trigger unit, control unit, switch unit, low-level modulator, discharger unit and, behind this, the main HT capacitor (*fig. 2*).

3. The transmitter blower is housed in a rectangular case normally mounted at the rear of the transmitter and is connected to it by a multicore cable and flexible trunking.

4. The transmitter comprises the following main assemblies and units:—

- (1) Oscillator unit Type 271
- (2) Meter unit
- (3) Discharger unit
- (4) EHT discharger and switch unit 407
- (5) Control unit Type 616
- (6) Trigger unit Type 2
- (7) Monitoring unit Type 82
- (8) Power unit (heaters) Type 887

- (9) Power unit (LT) Type 878
- (10) Power unit (monitor) Type 876
- (11) Power unit (trigger) Type 877
- (12) Rectifier unit (main HT) Type 26
- (13) Main HT transformer assembly
- (14) HT capacitor
- (15) HT choke
- (16) Charging reactor
- (17) Pulse forming network
- (18) Variac (LT)
- (19) Transformer unit Type 174 (HT Variac)
and mounted on the front of (19),
- (20) Capacitor unit.

Mechanical construction

5. The transmitter is mounted on two skids for ease of movement, each skid being fitted with four shock absorbers. A substantial welded steel base frame is used and two strengthened, cross-braced side panels are secured to this base by means of brackets and bolts. A welded channel-section top frame completes the main frame of the cabinet. A vertical member joins the top and bottom frames of the transmitter in the middle of the main frame at the rear; this carries the plugs and sockets, by which the external connections to the transmitter are made. The rear panels are bolted to the brackets which hold the main frames together. A rack frame mounted in the centre of the front part of the transmitter cabinet acts as the support for the individual chassis and divides the cabinet into three compartments. The more massive components are mounted on frames which are part of the main base frame. Small components and the auxiliary power supply units are mounted on frames, fitted like shelves, between the side panels and the centre rack. The cross-bracings of the side panels have threaded holes at the top so that screw eyes can be fitted to the transmitter for lifting purposes.

6. A small panel at the rear of the cabinet is removable to gain access to the LT Variac (*para. 73*).

7. The two front doors are hung on the cabinet by means of adjustable hinges, a screw being provided on each hinge to keep the faces of the two halves of the hinge out of contact. Inside each hinge, between the top of the hinge pin and this screw, there is a ball bearing which takes the entire load on the hinge. This type of hinge has very little friction and is necessitated by the weight of the right-hand door assembly. The doors are readily removable, a lift of 2.25 in. being sufficient to lift a door off its hinges. As the door is removed the balls will fall out and should be replaced, when the door is refitted, by removing the bolts in the top of the hinges.

Fans

8. There are three small fans inside the transmitter cabinet. Two, in the top, act as extractor fans for the left-hand compartment and the centre

(A.L.10, Oct. 56)

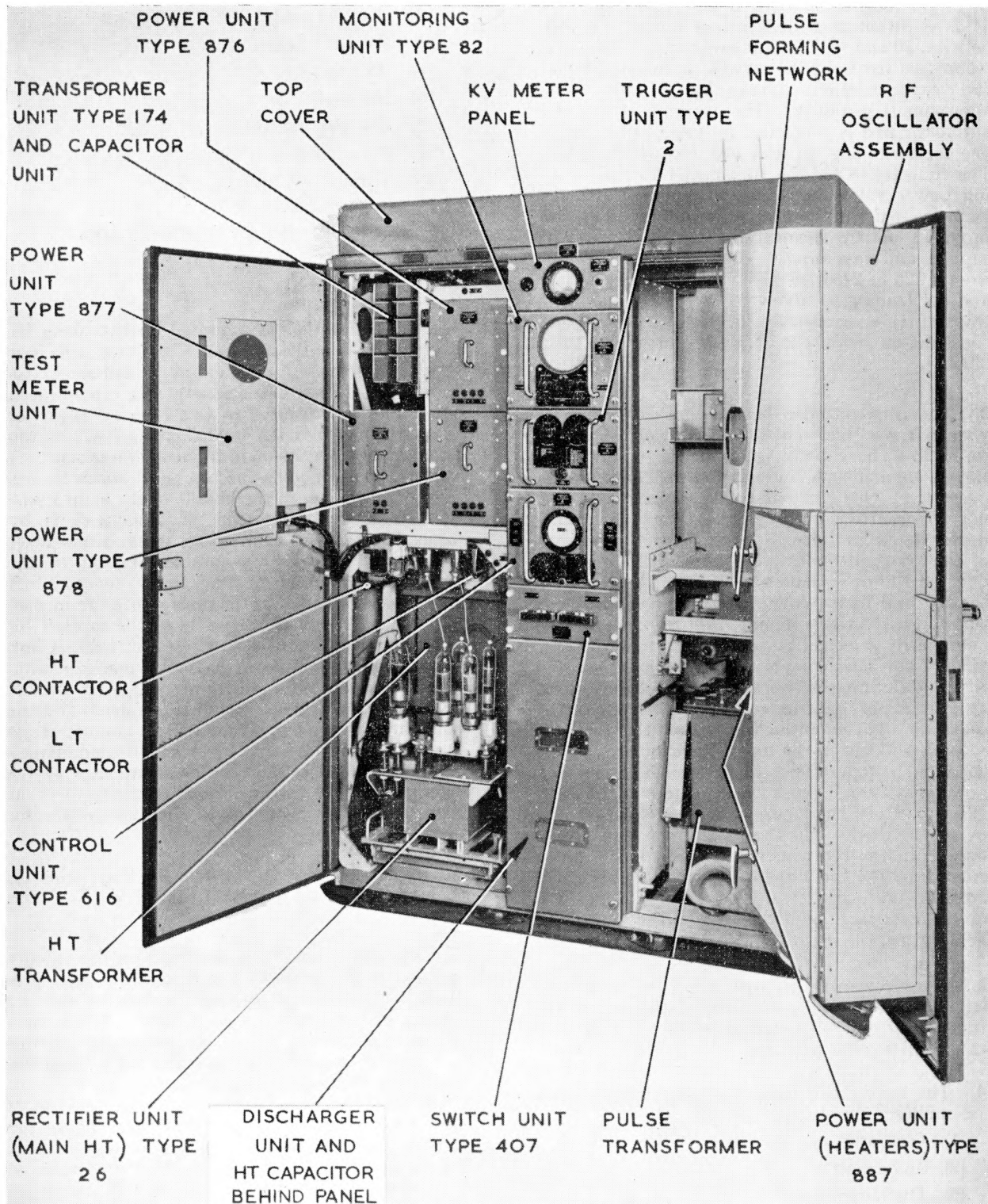


Fig. 2. Transmitter Type T.3705, with doors open

compartment, while the third, mounted in the left-hand compartment at the rear, beneath the HT variac, acts as a circulating fan. The three fans are all of the same type being rated at 275 cu. ft. per min. at $\frac{1}{4}$ in. water gauge, and are driven by 0.02 h.p., 200–250V single-phase induction motors running at 2880 RPM.

Interconnections within the transmitter

9. The majority of cabling within the transmitter is done in cableforms and details of interconnections between units will be found in fig. 29. The low voltage connections to units and sub-assemblies are normally made with 12-pin Jones plugs at the end of the cableform. High voltage leads are made with special coaxial cable, the screen being cut well back at the ends to prevent flash-over and breakdown. EHT leads are terminated in special plugs and sockets, or end on insulated terminals. RF and pulse signals are fed by coaxial cables terminated in standard coaxial connectors.

10. If a cable in the cableform should be found to be faulty, no attempt should be made to remove it. A new cable should be run in its place, following the old cable run or, where this is difficult to determine, the most convenient runs of the actual cableform. The ends of the old cable should be cut back as far as possible and then taped up.

Fuses

11. Details of fuses are given in TABLE I.

screening cover as they are in the RF compartment. This cover must be removed before they can be reached.

13. The only other indicator lamps on the transmitter are those on the front of the control unit Type 616 (*para. 76*).

Contactors

14. There are two contactors on the transmitter:—
(1) the LT contactor, controlling the AC supply to the auxiliary supply units which supply all LT and auxiliary HT supplies.

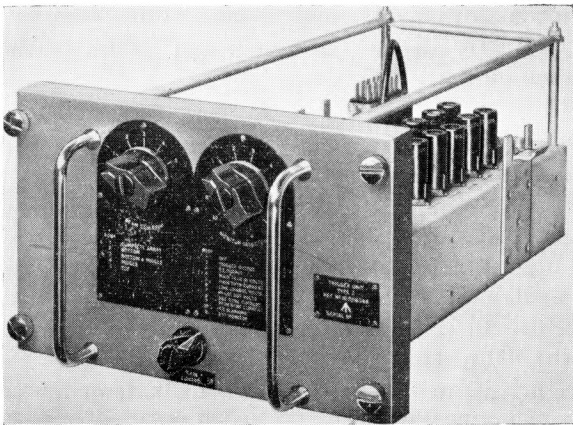


Fig. 3. Trigger unit Type 2—general view

TABLE I
Fuses, location and rating

Circuit	Location	Rating and Type
Primary of LT Variac	Left of LH compartment	2–15A Slydlock (28 SWG tinned copper fuse wire)
Internal fans	Right of LH compartment	2–5A cartridge
DC ON lamp	Top of LH compartment	1–500mA cartridge
AC to power unit, Type 876	On front panel of PU	4–5A cartridge
AC to power unit, Type 877	On front panel of PU	2–5A cartridge
AC to power unit, Type 878	On front panel of PU	4–5A cartridge
AC to control unit, Type 616	On front panel of control unit	2–5A cartridge

Indicator lamps

12. The main indicator lamps on the transmitter are the DC ON, FILS ON, and HT ON and HT UP lamps arranged in a line on the front member of the top frame, just above the doors. Each consists of a Perspex block with the appropriate lettering on it, behind which a lamp is mounted, the lamps being 230V 15W pigmy type. The lamps are mounted horizontally in standard bayonet holders which are mounted on vertical, hinged, plates, inside the front member of the frame. The frame is a channel section, and a small catch fitting into a notch on the frame holds the plates in position. When this catch is pressed the holder can be swung to the left so that the bulb can be removed. The two lamps HT ON and HT UP are provided with a

(2) the HT contactor, controlling the application of the AC supply to the primary of the EHT transformer. The two contactors are mounted just beneath the auxiliary power supply units in the left-hand compartment, the HT contactor being on the left and the LT contactor on the right. Each contactor has two main and two auxiliary contacts, an operating coil of 8800 turns with a resistance of about 300 ohms. and is designed for operation from a 50 volt supply.

TRIGGER UNIT TYPE 2

General

15. The trigger unit Type 2 (*fig. 3, 30 and 31*) is intended for use as part of either transmitter Type T.3692 in radar Type 15 installations or transmitter

(A.L.10, Oct. 56)

Type T.3705 in radar Type 7 installations. It is mounted in the middle compartment of the transmitter beneath the monitoring unit and comprises a chassis 21 in. long with a front panel $12\frac{1}{2}$ in. wide by $8\frac{1}{4}$ in. high. The chassis is supported on runners and is held closed by four quick-release fasteners. When these have been released the chassis can be pulled forward for inspections, etc. and after the leads connecting it to the cabinet have been removed and the two clamps at the rear of the chassis have been released the entire chassis can be lifted off the runners.

Function

16. The trigger unit has two functions:—

(1) To supply suitable trigger pulses to the modulator circuits, and to certain other circuits.

(2) To control the inputs and drives to the monitor unit.

17. The trigger pulse for the modulator is derived in one of several ways:—

(1) From a 250 c/s or 500 c/s sine wave from an external source.

(2) From an internal, free-running, 500 c/s oscillator.

(3) From a 250 c/s supply derived by dividing the 500 c/s supply of (2) by two.

(4) From an external pulse or squarewave with a recurrence frequency up to 550 pps.

(2) and (3) are only used operationally with transmitter Type T.3692. However, they may be used with transmitter Type T.3705 for test purposes, when working into a dummy load. From whichever input is selected the trigger unit generates pulses locked to the input, as follows:—

- (a) Modulator trigger pulse, +125V amplitude $6\mu\text{s}$ wide.
- (b) Monitor pre-trigger pulse, +110V amplitude $9\mu\text{s}$ wide [$9\mu\text{s}$ before (a)].
- (c) Test equipment pre-trigger pulses, +50V amplitude, $9\mu\text{s}$ wide [*coincident with (b)*].
- (d) Receiver blanking pulse, +10V 14–35 μs wide. Coincident with pulses at (b) and (c).

This output is not used in either the radar Type 7 or 15.

Controls

18. On the front panel of the trigger unit are mounted three controls, all concerned with the control of the monitor. They are:—

(1) The MONITOR SELECTOR SWITCH (SW2). This switch selects the input which is applied to the monitoring unit Type 82 for display.

The waveforms available for selection are:—

- (a) Receiver output.
- (b) Trigger unit output to discharger.
- (c) Input pulses to main thyatron.
- (d) Pulse current through main thyatron.
- (e) Voltage across pulse-forming network.
- (f) Output to main pulse transformer.
- (g) Secondary sync current (pulse transformer).

- (h) Primary sync current (pulse transformer)
- (j) Receiver blanking pulse.
- (k) Signal external to transmitter.

(2) The BEAM SELECTOR SWITCH (SW1). This switch controls the brightening pulses fed to the monitoring unit Type 82 (*para. 62*). By controlling the inputs to an electronic switching circuit brightening pulses at a p.r.f. of 250 pps or 62.5 pps are produced for the monitor. The monitor is triggered at 250 c/s by an output from the trigger unit and depending on the setting of the switch (SW1) the monitor will display:—

- (a) Every sweep (i.e. displaying at p.r.f. of 250 pps).
- (b) Sweeps in the series 1, 5, 9 etc. (i.e. display at p.r.f. 62.5 pps).
- (c) Sweeps in the series 2, 6, 10 etc. (i.e. display at p.r.f. 62.5 pps).
- (d) Sweeps in the series 3, 7, 11 etc. (i.e. display at p.r.f. 62.5 pps).
- (e) Sweeps in the series 4, 8, 12 etc. (i.e. display at p.r.f. 62.5 pps).

Successive RF pulses generated by the transmitter are fed to the top array, the middle array, the middle and bottom arrays and the bottom array, and the reflected signals are received on the array from which they are radiated, hence whenever the monitor is brightened at 1/4 p.r.f. it will only display the signals associated with one array of the complete aerial system. For this reason the switch is engraved:—

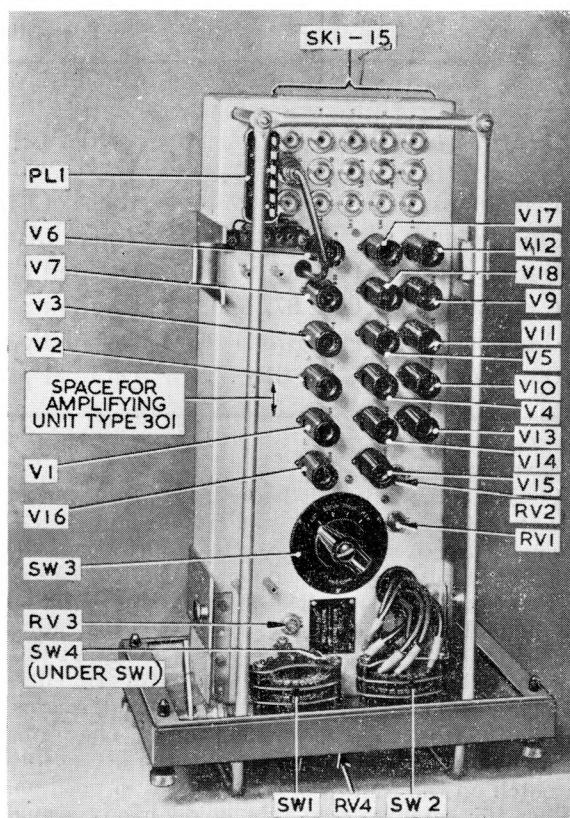


Fig. 4. Trigger unit Type 2—top chassis view

Position

- 1 Complete array
- 2 Bottom
- 3 Bottom and middle
- 4 Middle
- 5 Top

In between each position of the switch is a blank position.

3. The GAIN control (RV4) is a variable resistor common to the cathode circuits of the three IF stages of the monitor 45 Mc/s IF strip, amplifying unit (IF) Type 301 on the trigger unit and controls the overall gain of the unit.

19. On the chassis of the trigger unit are mounted five controls. They are:—

(1) The 15/7 switch (SW4). This switch is mounted on the chassis just behind the front panel of the unit. It is the master control switch which can be set so that the unit can be used as part of a transmitter Type T.3705 (radar Type 7) or as part of a transmitter Type T.3692 (radar Type 15). The switch controls the operation of the internal 500 c/s R-C oscillator by earthing its screen grid in the "7" position and at the same time disconnecting its output circuit from the input to the pulse generating circuits. This prevents the transmitter from being operated when not syn-chronized to the capacity switch, with possibility of damage, due to arc over.

(2) The trigger switch (SW3). This is a four-position switch (plus a blank position between each marked position) mounted in the middle of the chassis near the front and controls the selection of the input to the trigger unit. Its positions are as follows:—

(a) msw. In this position the unit is triggered from a sine wave; normally the MSW output from the capacity switch alternator. The instant at which triggering occurs can be varied with respect to the phase of the sine input by means of a phasing potentiometer mounted on the chassis.

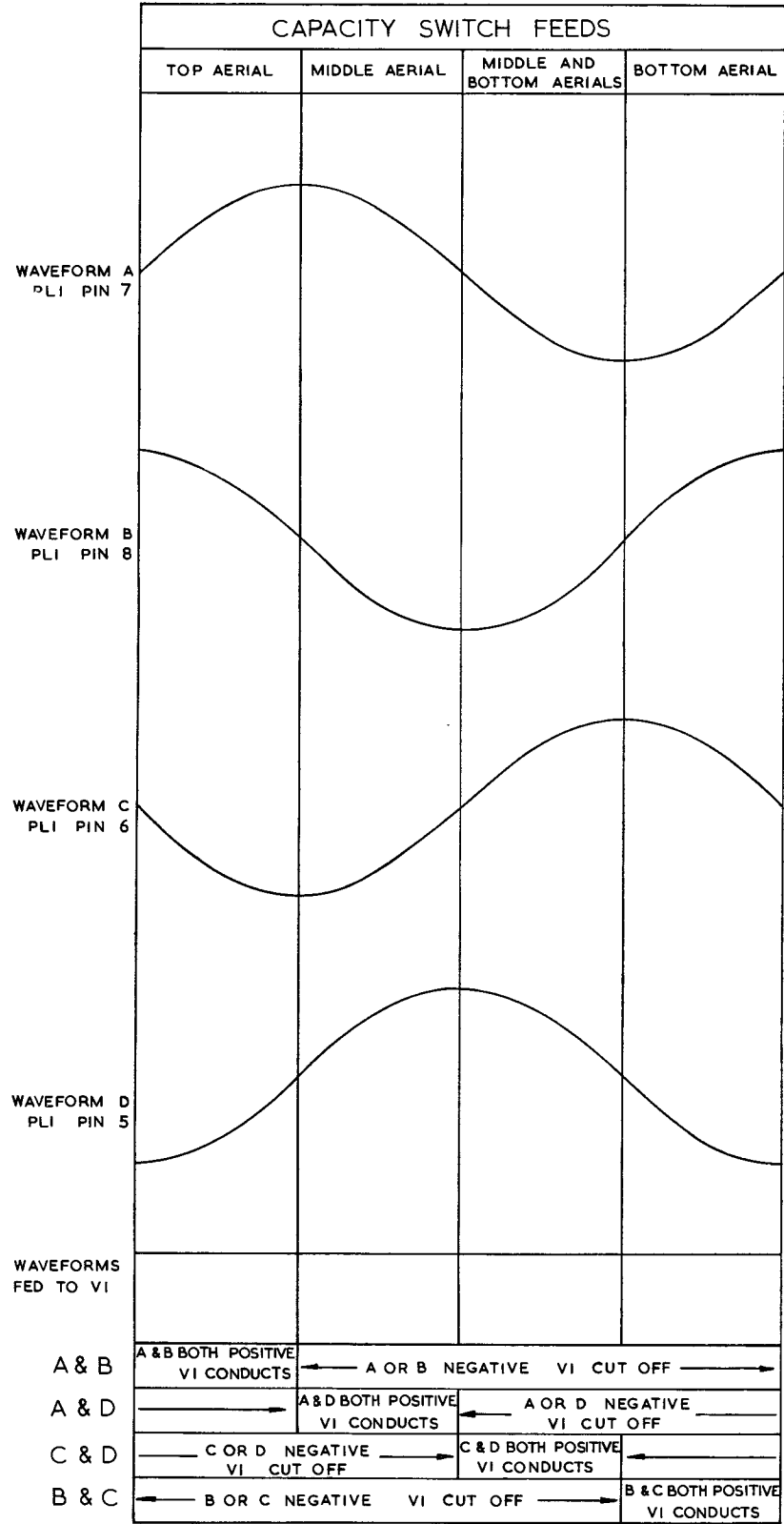


Fig. 5. Trigger unit switching—explanatory

- (b) **500c/s.** In this position the unit is triggered by an internal free-running R-C phase shift oscillator at a p.r.f. of 500 c/s.
- (c) **250 c/s.** In this position the unit is triggered by an internal 500 c/s R-C phase shift oscillator followed by a trigger circuit which divides by two at a p.r.f. of 250 c/s.
- (d) **EXT.** In this position the unit is triggered by pulse or squarewave from external source.

Note . . .

The 500 c/s and 250 c/s positions of the switch are not operative when the 15.7 switch is at 7.

In the Radar Type 7 the normal position of this switch is at EXT when the unit is triggered by a 250 c/s trigger pulse from the master trigger unit (rack assemblies Type 180-183) which is locked to a 250 c/s sine wave from the capacity switch on the radar aerial array.

(3) **RV1.** This controls the length of the pulse supplied for receiver blanking. (*Not used*).

(4) **RV2.** This controls the bias on an amplifier handling the sine wave input when the trigger switch is at MSW, and hence the phase of the trigger pulse which is produced.

(5) **RV3.** This provides fine control of R-C phase shift oscillator frequency, by altering the phase shift in the cathode circuit of the valve.

20. All plugs and sockets are mounted on the top of the chassis at the rear. Their functions are as follows:—

(1) **SK1.** Coaxial socket carrying positive pulse of at least 110V in amplitude which is used to trigger monitoring unit Type 82.

(2) **SK2.** Coaxial socket carrying positive pulse of at least 125V amplitude which is used for triggering discharger unit. This pulse occurs 9 μ s after pulses at SK1 and SK3.

(3) **SK3.** Coaxial socket carrying positive pulse of 9 μ s duration and at least 50V amplitude which is used for triggering external test equipment.

(4) **SK4.** Coaxial socket carrying pulse of 14–25 μ s duration (controlled by RV1) and at least 10V in amplitude when feeding into 220 ohms load. This pulse is coincident with that at SK1.

(5) **SK5.** Coaxial socket carrying brightening pulse to monitoring unit.

(6) **SK6.** Coaxial socket carrying positive-going pulses of 15V amplitude from external source for driving trigger unit.

(7) **SK7.** Coaxial socket carrying detector current to test meter unit (*para. 97*).

(8) **SK8 to SK14.** Coaxial sockets carrying inputs to monitor selector switch.

(9) **SK15.** Output from monitor selector switch to monitor.

(10) **SK16.** Coaxial socket on IF amplifier Type 301. Carries input from receiver to monitoring IF amplifier.

(11) **SK18.** Coaxial socket carrying brightening pulse from monitor.

(12) **PL1.** 12-pin Jones plug carrying supplies and MSW input to unit and 4-phase $\frac{1}{4}$ p.r.f. supply from capacity switch to electronic switching circuit.

(13) **PL2.** Coaxial lead connecting output socket of IF amplifier to monitor selector switch.

Circuit description

Sine wave trigger (MSW)

21. When the trigger unit is operating from a sinewave trigger (that is, with the trigger switch at MSW) the incoming sine wave is fed in on PL1 (4) and applied, via a network R78-C46 which introduces a fixed phase shift and some attenuation to one grid of V13, a double triode Type CV.858. The cathode of this valve is held approximately 18V positive to earth by the second half of the valve which has its grid strapped to cathode. In the grid circuit of V13 is a squaring resistor R43 and from the anode a clipped sine wave is obtained. The PHASING control (RV2) in the cathode circuit of the valve determines the bias on V13 and hence the position of the operating point on its i_a/V_g characteristic. This means that the width of the clipped top and bottom of the output sinewave will vary with the setting of RV2, and the output can be regarded as, effectively, a rectangular waveform with variable mark/space ratio.

22. This waveform is used to control a sawtooth waveform generator (half of V14, Type CV.858). This valve is normally conducting and hence the voltage across C27 is low. When the grid of the valve is driven negative the valve will cut off and allow C27 to charge exponentially from the HT supply via R46. When the grid is driven positive again C27 will discharge through the valve. As the time constant C27 – R46 is long compared with the time constant C27 and r_a of V14, the waveform across C27 will be a sawtooth. This sawtooth is differentiated in C25 – R48 and produces a negative pulse train coincident with the back edge of the rectangular waveform produced by V13. These pulses are amplified in the second half of the double triode and fed to the grid circuit of V15, also a double triode Type CV.858.

23. Valve V15 has two functions. In the 250 c/s position of the trigger switch it acts as a stable trigger circuit (*para. 30*). In the other positions of the switch only one-half of the valve is used, and it then acts as a conventional pulse amplifier. From its anode (*pin 2*) a negative-going pulse is applied to the cathode of diode V8 Type CV.1092 and also to the grid of double triode V10 Type CV.858.

24. V10 is connected as a flip-flop circuit and produces a negative pulse 15–25 μ s wide at the anode (*pin 1*). When triggered by a negative pulse on its grid (*pin 5*), the negative pulse from anode (*pin 1*) is fed to the grid of V11 Type CV.138. This valve is a pentode connected as a zero bias amplifier and feeds a positive pulse to the grid of pentode V12 Type CV.138 which is connected as a triode cathode-follower and feeds a 20V positive pulse to SK4 for receiver blanking. The pulse is 15–25 μ s long, starting 9 μ s before the pulse which triggers the discharger and lasting from 2 to 12 μ s after the transmitter pulse ends, its duration being controlled by RV1 in the flip-flop circuit.

25. The negative pulse on the cathode of V8 causes it to conduct. This excites the ringing circuit (L2–C14) connected between its anode and earth so causing it to ring; the first half cycle is negative. The ring is applied to both halves of double triode V9 Type CV.858 which are both connected as zero bias amplifiers. The negative-going first half cycle is amplified producing positive pulses $9\mu\text{s}$ wide in the anode circuits while grid current in both triodes damps out the remainder of the ring. V8 prevents the positive swing of the waveform on the grid of V10 from energizing the ringing circuit at the end of the receiver blanking pulse.

26. One half of V9 feeds a 50V positive pulse to SK3 for triggering an external test oscilloscope while the other half of V9 feeds a similar $9\mu\text{s}$ pulse to the grid of valve V3, which drives V5 Type CV.138, whose anode circuit is connected to SK1 providing a 110V positive pulse for triggering the monitoring unit Type 82, and also to the grid of V6 Type CV.138.

27. In the grid circuit of V6 a ringing circuit is connected. This circuit is not affected by the leading edge of the $9\mu\text{s}$ pulse from V9 as any tendency to ring is immediately damped out by grid current flowing in V6, connected as a zero bias amplifier. On the trailing edge of this $9\mu\text{s}$ pulse the circuit rings, the first half cycle being negative. The remainder of the ring, after the first half cycle, is suppressed by grid current and the result is a positive pulse in the anode circuit of V6 of $6\mu\text{s}$ duration, but delayed $9\mu\text{s}$ on the pulse on the grid. This pulse is fed to the grid of cathode follower V7 Type CV.138, a triode-connected pentode which feeds a positive pulse of about 125V peak to SK2 for triggering the discharger unit.

Sine wave trigger (Int. 250 or 500 c/s)

28. When the trigger switch is in the 250 c/s or 500 c/s positions the trigger unit is locked from an internal, free-running 500 c/s oscillator. Although these positions are inoperative when the "15/7" switch is at "7" the description is included here for completeness.

29. Pentode V16 Type CV.138 in association with C30–33 and R58–61 forms an R–C phase-shift oscillator generating a sine wave output at a normal frequency of 500 c/s, fine control of frequency being obtained by RV3 in the cathode circuit of the valve. The output of the oscillator is fed via the "15/7" switch to the trigger selector switch and thence to the grid of V13, and the circuits described in para. 21 to 26. The rest of the circuit, when the switch is in the 500 c/s position is as already described for the MSW position.

30. With the switch in the 250 c/s position V15 is used as a stable trigger circuit to count down 2:1 and so to provide a square wave output at 250 c/s from a 500 p.p.s. pulse input. C45 and R28 form a differentiating circuit which differentiates the 250 c/s square wave and V8 conducts on the negative pulses and the ringing circuit L2–C14 and the following stages operate as described in

para. 25 and 26. It should be noted that V8 in the same way that it did not pass the positive-going swing at the grid of V10, does not pass the positive pulses of the differentiated waveform.

External pulse trigger (EXT)

31. When the trigger selector switch is at EXT, a positive pulse is fed in on SK5 or 6 and fed to the grid of V17, Type CV.138 which amplifies it before it is used to trigger a flip-flop circuit V18, Type CV.858. If the incoming pulse is more than $20\mu\text{s}$ wide it will be differentiated by C43–R76 before reaching the grid of V17. V18 produces a $10\mu\text{s}$ negative pulse which is applied as before to the cathode of V8 to produce the $9\mu\text{s}$ pulse.

Monitoring unit brightening pulses

32. The electronic switching circuit referred to in para. 18 is formed by V1, V2 and V3. Four sine waves at one quarter of the p.r.f. and differing in phase from each other by 90 deg. (that is, 0 deg., 90 deg., 180 deg. and 270 deg.) are fed into the Jones plug PL1 and from this to the beam selector switch SW1, while a pulse at 250 c/s is fed in to SK18, from the monitor. The beam selector switch selects either the 250 c/s pulse or the appropriate pair of sine waves (A, B, C & D on fig. 5) for application to the grids G1 and G3 of pentode V1, Type CV.138. When the 250 c/s pulse is applied to the grid G1 of V1, this valve and V2 act as a two stage pulse amplifier and, from the anode of V2 a positive pulse is obtained which is fed via SK6 to the monitoring unit. Here it is used as a brightening pulse so that the monitor sweep is at an effective p.r.f. of 250 c/s. When the $\frac{1}{4}$ p.r.f. sine waves are applied to V1 the valve is heavily overdriven as the sine wave amplitudes are large and anode current will only flow in V1 when both grid and suppressor are positive, that is, when both driving voltages are positive. Squaring resistors R2 and R4 prevent the grids going very positive during the positive half-cycles of the sine wave input and the output of V1 consists of a train of negative pulses at a repetition frequency of 62.5 c/s the pulse occurring at the time when the capacity switch is feeding the aerial array selected on SW1. This negative pulse is amplified and inverted in V2, Type CV.138, is fed out to the monitor as the brightening pulse, so that the monitor sweep is now at an effective p.r.f. of 62.5 c/s.

Amplifying unit (IF) Type 301

33. The amplifying unit (IF) Type 301 is a sub-assembly, mounted on the trigger unit chassis, and used to amplify and detect, for monitoring purposes, the 45 Mc/s IF output from the radar receiver. The 45 Mc/s received signal is fed from the receiver to the transmitter and thence to the three-stage IF amplifier formed by valves V1–V3 (all Type CV.138). This amplifier has a mid-band frequency of 45 Mc/s and a bandwidth greater than 2.2 Mc/s at 3 dB down. The maximum gain of the IF amplifier is approximately 55 dB and is controlled by the GAIN potentiometer (on the front of the trigger unit) which is connected in the cathode circuits of the three IF valves, controlling the bias on them.

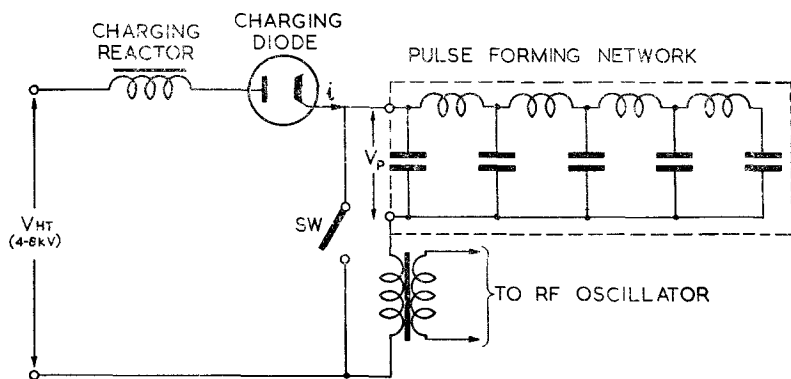


Fig. 6. Simplified circuit of high level modulator

34. The IF amplifier is followed by a double diode V4, Type CV.140, which is connected as a detector and peak limiter. The positive output of the detector is fed to the grid of V5, Type CV.2179. The signal on the grid is limited by the second half of V4 connected as a peak limiter clipping any pulses which would tend to drive V5 positive. V5 functions as a video amplifier feeding a negative pulse to the output socket SK17 on the IF strip from which a cable feeds the monitor via the monitor selector switch. Overall gain of the IF unit is about 85 dB.

MODULATOR AND R.F. OSCILLATOR

General

35. A DC HT voltage of up to 8 kV is obtained from the EHT power supply and fed to the high power modulator which produces a $4\mu\text{s}$ pulse at a voltage of from 6–11.5 kV for applying to the RF oscillator valves.

Modulator (fig. 6 and 32)

36. A simplified circuit diagram of the high power modulator is shown in fig. 6. The action of the circuit is as follows:—

Assuming that the pulse-forming network is uncharged, it will start to charge from the EHT supply through the charging reactor and the charging diode. The rate of charge will be slow compared with the duration of the pulse which the pulse-forming network is designed to produce, and the pulse-forming network will act as a capacitor, the inductance of its elements being negligible compared with that of the charging reactor.

37. This circuit (*reactor-diode-line*) forms a series-resonant circuit of low impedance which is shocked into oscillation. The voltage across the pulse-forming network and the current into it would, but for the charging diode, follow the dotted-line curves in fig. 7. The maximum voltage which appears across the pulse forming network is almost twice the EHT voltage. When the voltage across the network reaches a maximum, the charging current falls to zero and then the network attempts to discharge. However, the charging diode can only pass current from the HT supply into the pulse forming network and so it cuts off, leaving the pulse-forming network charged at the maximum value of voltage which it attains, that is, the voltage across the network follows the full line in fig. 7. Any energy still stored in the charging

reactor is dissipated as an oscillation in the resonant circuit formed by the inductance and self-capacitance of the reactor.

38. At a suitable instant after the voltage across the pulse-forming network has reached the maximum value, the switch SW closes and connects the network across the primary of the pulse transformer. The network is discharged through the pulse transformer producing a $4\mu\text{s}$ pulse across the transformer primary of slightly less than the original EHT voltage (the output voltage of a pulse-forming network during discharge is half of its charged value, assuming that it is correctly terminated).

Detailed description

Discharger unit (fig. 8)

39. The discharger unit, which is mounted at the front of the central compartment, has on it the main thyatron, Type CV.2203, which acts as the switch which discharges the pulse-forming network. It has, also, circuits for producing a suitable pulse for firing the thyatron.

The 125V positive pulse of $6\mu\text{s}$ duration from the trigger unit SK2 is applied to the grid of a small thyatron V1, Type CV.372, which is connected between the input of a small pulse-forming network (X1) and earth. This pulse-forming network is charged from the 550V supply obtained from the power unit 877, via a 10 K-ohms resistor, to a potential of 550V. The firing of the thyatron discharges the network and produces a negative pulse of 5 micro-seconds duration and about 275V amplitude which is applied to the grid of the main thyatron via a 2:1 step up transformer (TR2) which reverses the pulse to give a 550V positive pulse on the thyatron grid. This pulse fires the main thyatron which discharges the main pulse-forming network, as described in para. 38.

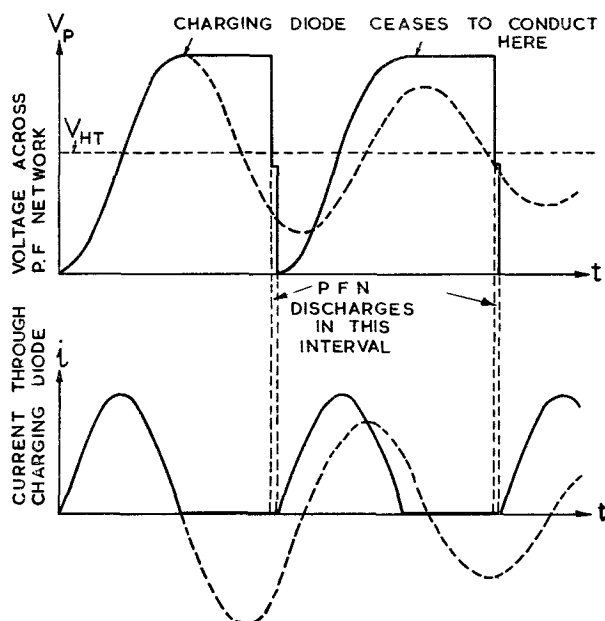


Fig. 7. Charging of pulse forming network

In addition, the discharger unit provides two pulse outputs for monitoring purposes:—

(1) Trigger pulse to main thyatron (SK4).

(2) Pulse current through main thyatron (SK3).

Both these outputs are fed to the monitoring unit Type 82.

Charging reactor and charging diodes

40. The charging diode consists of two rectifiers, Type CV.2160, connected in parallel. These two valves are mounted on the rectifier unit Type 26, (*para. 65*). The pulse produced across the pulse transformer is of 4–8 kV peak-to-peak and duration 4 μ s. The pulse transformer has a step up ratio 1.54:1 and applies a positive pulse of 6–11.5 kV to the anodes of the RF oscillator valves. The Q of the oscillator assembly in the non-oscillating condition is so high that the oscillator will operate with an HT voltage of as low as 50 volts. In order to prevent the oscillator operating during the charging cycle, when small transient voltages may be produced in the secondary of the pulse transformer, an enclosed spark gap, Type CV.2902, is connected in the lead from the pulse transformer to the R.F. oscillator. This gap will only conduct when the voltage developed across it exceeds its breakdown voltage, so, during the actual modulator output pulse the gap will conduct and the circuit will operate normally, but between pulses the gap will remain open-circuited. Thus the gap ensures that there is no possibility of the oscillator firing except during the main pulse. The spark gap is mounted inside a glass envelope, filled with an inert gas, and plugs into a holder mounted on top of the main pulse transformer. This holder includes in the valve base a safety spark gap which fires if the main gap fails. Connected across the main thyatron is an overswing diode. The main function of this overswing diode is to prevent the pulse-forming network from becoming negatively charged at the end of the output pulse. This might occur if the impedance presented to the pulse-forming network by the pulse transformer is lower than the characteristic impedance of the pulse-forming network. A negatively charged pulse-forming network would mean that a reversed voltage would be applied across the thyatron which would be detrimental to it. The overswing diode prevents this occurring by discharging the network if it should accumulate a negative charge. It also helps to suppress any parasitic oscillation in the pulse transformer and the discharge circuit and so prevents the possibility of double pulsing.

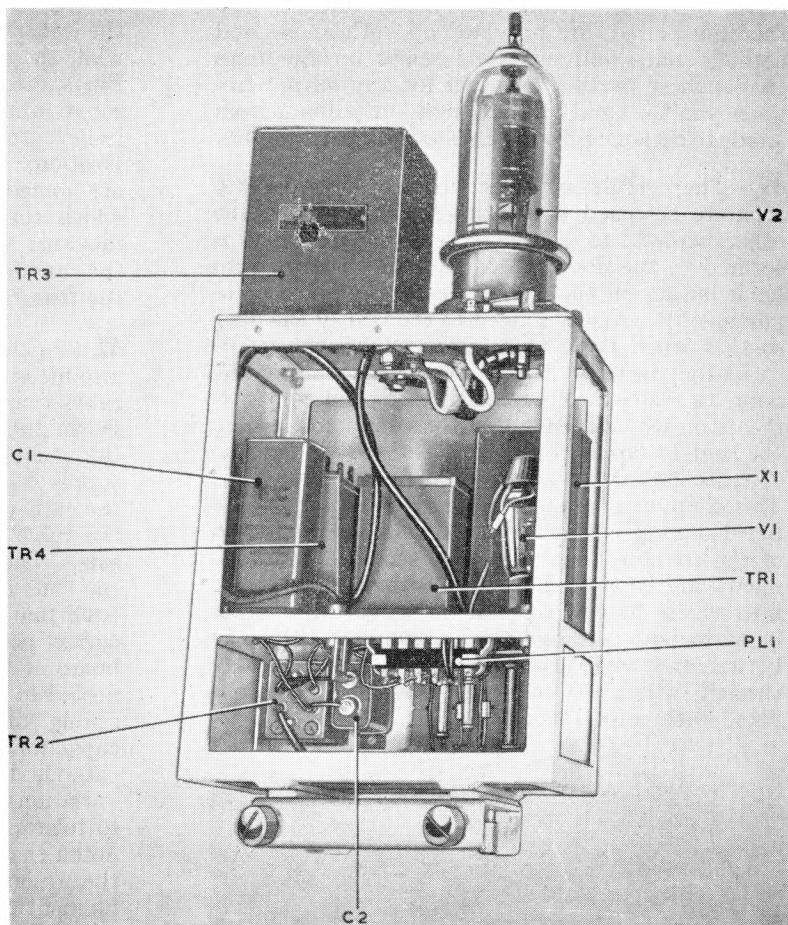


Fig. 8. Discharger unit

Mechanical construction

41. The discharger unit is mounted at the bottom of the central compartment. It is held in place by two captive bolts which screw into the front of the bottom frame and by two dowel pins on its base.

42. The main pulse-forming network and the power unit (heaters) Type 887, are mounted on telescopic runners so that they can be pulled forward for inspection after the connections to them have been removed. The runners are locked in the closed position by two catches.

43. The main pulse transformer is mounted in the bottom of the right-hand compartment, at the rear, on an angle frame. Holes on its rear mate with pins on the framework while the front is held down by bolts. Extensions of the frame are bolted to the pulse transformer and can be hinged forward on to a wood block so that the pulse transformer can be slid forward and removed if necessary.

RF oscillator Type 271

44. The RF oscillator (*fig. 9*) is of somewhat unusual construction, being built onto the back of the door of the right-hand compartment. It comprises two forced-air-cooled triodes, Type CV.2163, in a push-pull tuned-cathode, tuned-anode, grounded-grid circuit (*fig. 10*). The anode

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and cathode circuits are formed by $3\lambda/4$ parallel lines (lecher lines) which are rhodium plated to resist corrosion. Adjustable metal bridges, also rhodium plated, are provided on both anode and cathode lines and engraved scales on the lines enable these bridges to be set for any output frequency in the band 185–215 Mc/s. Feedback from anode to cathode is by a $\lambda/2$ resonant line (*para. 48*).

45. The oscillator assembly is housed into separate screened compartments, one above the other, screwed to a large screening plate which is secured to the door by 15 bolts which screw into hank bushes on the door frame. The lower compartment is actually hinged to the rear of the door so that when these bolts are removed the whole oscillator assembly can be swung away from the door, to reach the front of the screened compartments on which is mounted the conductor feeding the heaters supply to the oscillator valves and also the mechanical turning drive for the coupling line. This coupling consists of a screwed rod rotated by bevel gears, giving a very fine control of the length of the coupling line. The two screened compartments are separated by an earthed metal plate into which the grid rings of the valves fit, contact being made by spring fingers around the holes. In between the two valves there is a hole in the plate through which the coupling passes. This hole is fitted with corona shields.

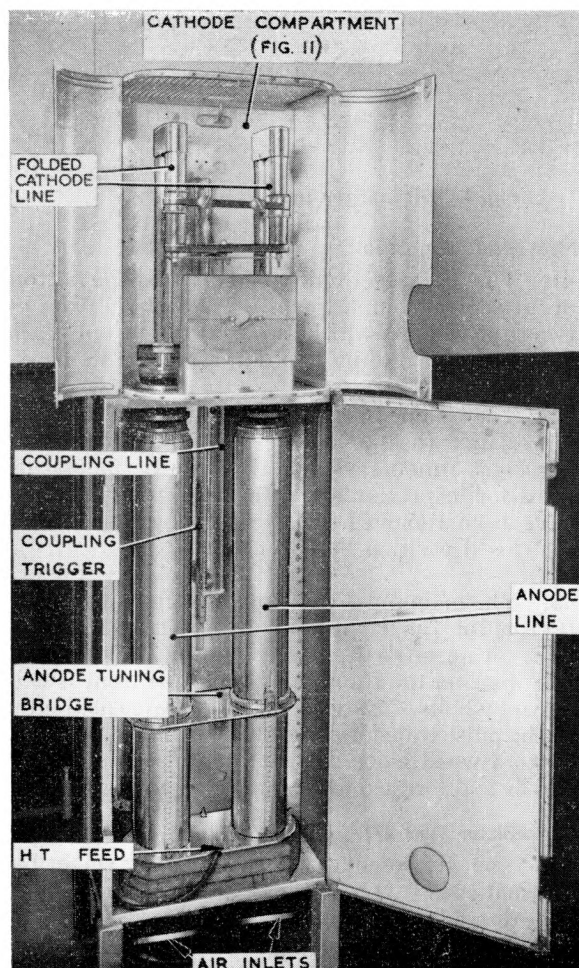


Fig. 9. RF oscillator Type 271—with doors open

46. The anode lecher tubes are mounted vertically in the lower screened compartment which has a hinged door with two locks. The lower ends of the lecher tubes are supported on a Mycalex block, while the anodes of the valves fit into the top ends. Plugs, attached to each anode by three 2BA bolts, screw into threaded sockets inside the tops of the lecher tubes, and so hold the valves in position. The lower ends of the lecher tubes are joined by a metal plate to the centre of which the HT supply to the valves is fed. A movable shorting bridge is provided for tuning the anode lechers over the frequency range of the transmitter.

47. In the upper screened compartment, which is also fitted with doors, there are mounted the lecher tubes connected to the cathodes of the valves. Down the centre of the cathode lecher tubes are the conductors to the valve heaters. The AC supply for the valve heaters is connected between the cathode lechers and these centre conductors as the valve heaters are connected to cathode on one side. The cathode lechers are folded back near the ends remote from the valves so that the feedback line from the anode compartment is in the correct position relative to the cathode line. Inside boxes at the bend of the lines are RF filters connected in the valve heaters circuit, the filters consisting of a RF choke and two feed-through capacitors. The inner conductor of each of the cathode lines is adjustable to take account of variations in the positions of the filament pins due to tolerances in valve manufacture. It should be noted that these inner conductors form no part of the resonant circuit and serve only to supply filament current to the valves.

48. The resonant lines in the anode and cathode circuits of the oscillator cannot be made $\lambda/4$ in length because, owing to the size of the valves and the resulting stray capacities, the length of line required to tune the anode and grid circuits to resonance at the frequency of operation of the transmitter would be so short as to be non-existent at the upper end of the frequency band. It is more normal in such a case to use lines of different lengths in anode and cathode, say $5\lambda/4$ in the anode circuit and $3\lambda/4$ in the cathode circuit, the use of lines with lengths differing in multiples of $\lambda/4$, ensuring that the oscillator will only oscillate at the desired frequency. Lines $5\lambda/4$ in length are unwieldy at frequencies of 200 Mc/s and for this reason $3\lambda/4$ lines are used in both anode and cathode circuits. However, the use of $3\lambda/4$ lines in both anode and cathode circuit would normally mean that the oscillator will operate at one-third of the desired frequency with the resonant lines acting as $\lambda/4$ circuits. It is for this reason that the anode and cathode circuits are mounted in separate compartments, carefully screened, one from the other, and the coupling between anode and cathode lines provided by a parallel line $\lambda/2$ in length, shorted at each end, which protrudes from one compartment into the other. This line is only resonant at the output frequency of the transmitter and prevents feedback from the anode circuit to cathode circuit at any other frequency. The coupling lines is made from two telescopic lines shorted at each end, and

its length, which determines its operating frequency, can be preset to one of five settings. Final adjustment of the length of line and hence of the tuning can be made by means of a geared control knob on the front of the compartment door. The Q of this $\lambda/2$ resonant line is very high ($Q \sim 20,000$) and if it were undamaged the oscillatory voltage induced in it would be so high that it would cause a flash-over. For this reason the coupling line is also used as the output coupling circuit and the feeder to the transmitter output is connected to tapping points on it; this puts a load of 330 ohms across the line, reducing its Q to about 10, and decreasing the RF voltage on the line. The position of these taps is critical as the load on the line will determine the amount of feedback applied to the oscillator and hence the power delivered to the load. It will also have a second order effect on the frequency of oscillation.

49. The lecher tubes are designed to be of low characteristic impedance. This means that the lines are of low inductance/capacitance ratio and so fairly high inter-electrode capacitances of the valves will have the minimum possible effect on the tuning. The valves have a metal anode block with very fine fins through which passes the cooling air, blown up the inside of the anode lecher lines. About 200 cu. ft. per minute at a pressure of at least 7 in. water gauge is fed to each valve. The anode, grid and cathode are mounted in the valve coaxially and the cathode has a surface area of 16 sq. cm. The grid wires are gold plated to reduce secondary emission. The valve heater consists of two separate sections in parallel, each heats half the cathode, the total heater current being 6.7A at 16V. The valve will operate reasonably satisfactorily with one of these sections open-circuit. One valve is capable of supplying 1.5 kW of RF power so the valves are conservatively operated in this equipment as the mean RF power output from two valves is approximately 1.6 kW.

Note . . .

When these valves are switched on, the heaters supply must be on for at least four minutes, but not more

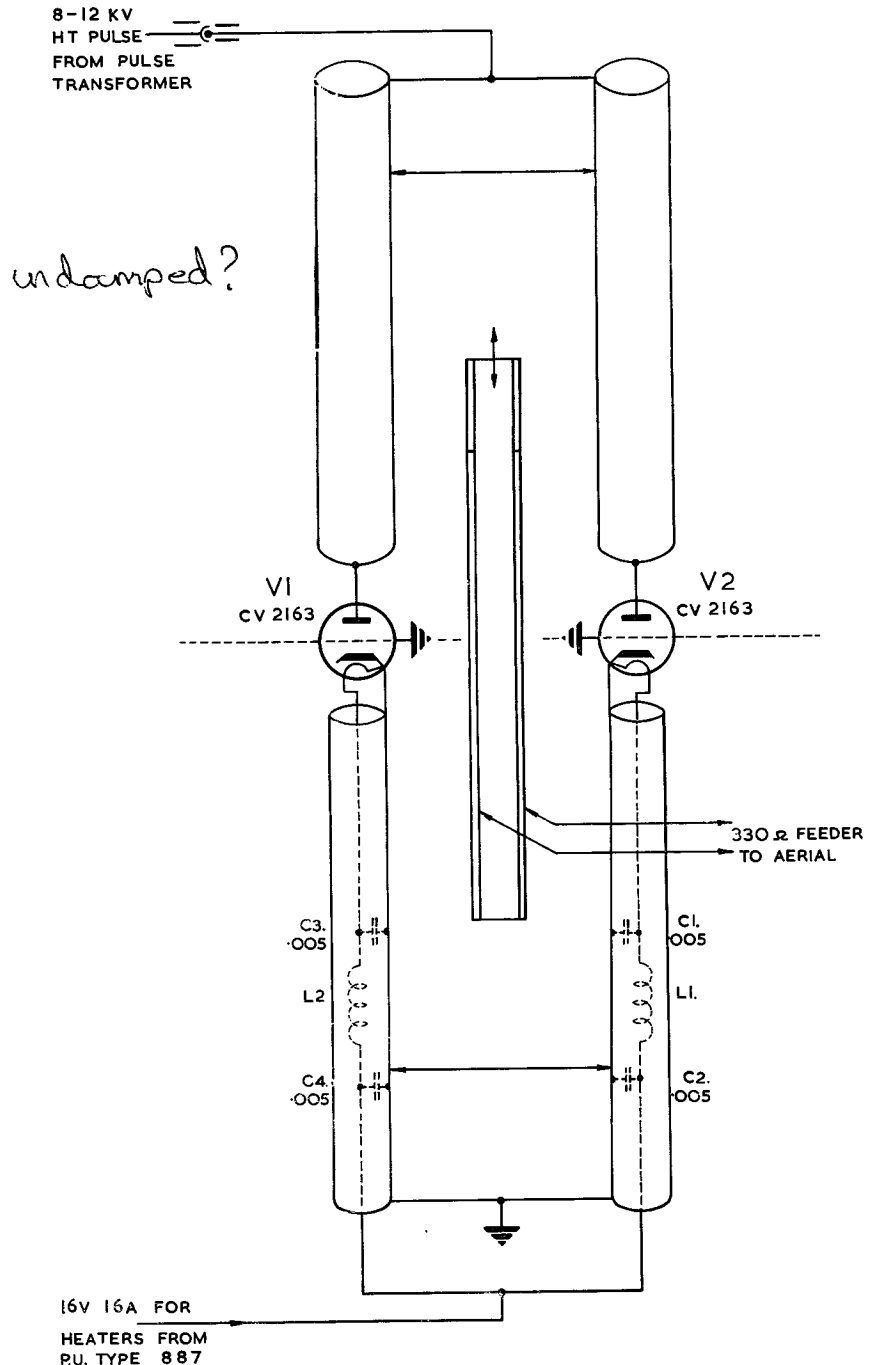


Fig. 10. RF oscillator Type 271—circuit

than 15 minutes, before the HT is applied. The control circuits meet this requirement automatically.

50. As already mentioned, the air for cooling the oscillator valves is blown up the inside of the anode lechers. This air supply is obtained from the fan assembly Type 26 external to the transmitter (*para. 99*). This assembly supplies at least 380 cu. ft. per minute at a pressure of at least 7 in. water gauge. The air supply reaches the oscillator valves, via a forked tube with a sloping front face, at the foot of the right-hand compartment. Rubber extension sleeves on the end of the anode lechers

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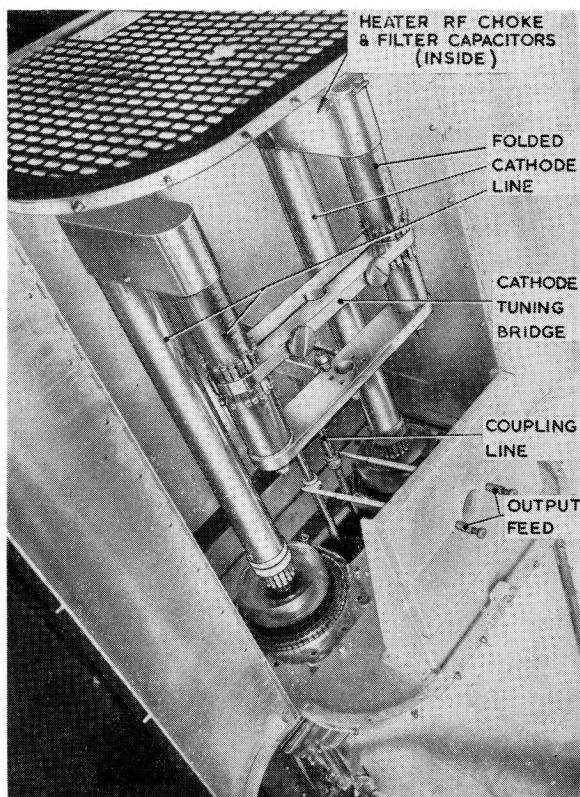


Fig. 11. Cathode compartment of RF oscillator Type 271

bed on to this front face and form an air-tight seal when the door is closed. The position of the fork is adjustable.

51. When the door is closed, its weight is taken by a latch and pin at the bottom of the door. This ensures that there is no strain on the bolt of the locking handle or on the interlocking mechanism.

52. The RF output is taken from the coupling line by means of a length of telescopic parallel line connected between adjustable tapping points on the coupling line, and spring buttons mounted on a polystyrene support plate at the rear of the cathode compartment. When the door is closed these buttons make contact with a length of 330-ohms parallel line feeder consisting of two $\frac{1}{4}$ in. copper tubes spaced two inches apart; these are connected to output pins on the top of the transmitter cabinet.

MONITORING UNIT TYPE 82

General

53. The Monitoring Unit Type 82 is mounted just beneath the HT meter panel at the top of the middle compartment of the transmitter. The construction and mounting of the unit is similar to that of the trigger unit (*para. 15*). It includes a 6 in. electrostatic cathode ray tube with a short persistence screen together with the necessary sweep generation and calibration circuits. Four ranges of sweep are available, 2.5 miles for monitoring waveforms in the transmitter and 50, 100 and 250 miles for display of received signals, primarily for monitoring purposes. Two calibration signals are available, a pulse at $2\mu\text{s}$ intervals for use when monitoring waveforms and a pulse (at a repetition

frequency corresponding to range intervals of 5 miles) for use when the received signals are being displayed. Selection of the sweep range automatically selects the appropriate calibration circuit so that when the CAL switch is closed the correct calibration pips are applied to the CRT.

Controls

54. On the front panel there are the following controls:—

- (1) RANGE AND CALIBRATION switch (SW1). Selects sweep range of 2.5, 50, 100 or 250 miles and appropriate calibration pips of either $2\mu\text{s}$ or 5-mile spacing.
- (2) SWEEP LENGTH (RV38). Adjust length of trace on tube.
- (3) FOCUS (RV61). Controls focusing of CRT.
- (4) BRIGHTENING (RV65). Controls voltage on cathode of DC restorer and hence average brightness of display.
- (5) X-SHIFT (RV49). Controls voltage on cathode of DC restorer connected to one of the X-plates of CRT and hence position of CRT sweep.
- (6) EHT ON-OFF SWITCH (SW2). Controls application of AC to associated power unit.
- (7) CAL ON-OFF switch (SW3). Switches calibration markers on when desired.

55. Preset controls on the unit are:—

- (1) RV15. Frequency control for oscillator generating 5 mile calibration markers.
- (2) RV78. Frequency control for multivibrator generating $2\mu\text{s}$ calibration markers.
- (3) RV102. Sweep duration.

Sweep generator

56. A double triode V1 Type CV.858 is used in a cathode-coupled flip-flop circuit, being triggered by a positive pulse of $7\mu\text{s}$ duration and 110V amplitude from the trigger unit Type 2. The output from the anode (pin 1) is a rectangular positive pulse of one of 4 durations, depending on the setting of the range switch. This pulse is clipped at its positive edge by V3A ($\frac{1}{2}$ -CV.140), the cathode of which is held at approximately +270V. The negative

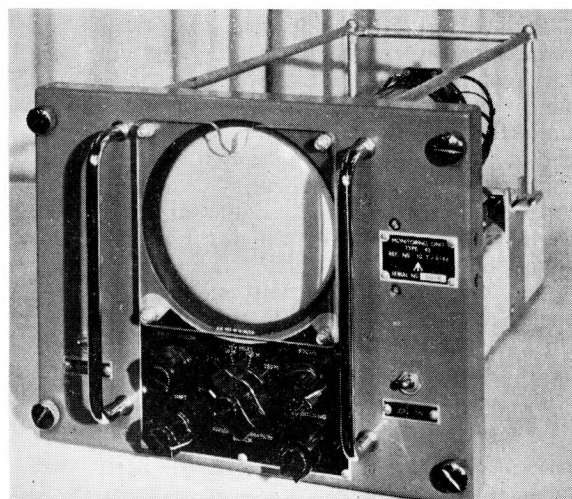


Fig. 12. Monitoring unit Type 82—general view

edge of the pulse is held constant by the anode (pin 1) of V1 "bottoming". Thus a rectangular pulse of constant amplitude, but with its duration depending on the setting of the range switch (SW1) is generated by V1. A portion of this pulse, that developed across R33, is fed to the brightening pulse circuits (*para. 62*).

57. The whole of the pulse is applied to the circuit consisting of V3B–R45 and a capacitance consisting of wiring strays plus, possibly, C25, C26, or C27. This we will call C_s . On the positive front of the pulse and during the pulse the diode V3B cuts off and C_s charges through R34 thus producing an exponential saw-tooth waveform across C_s . At the end of the pulse cathode voltage of V3B falls until it is negative with respect to its anode and then V3B conducts and C_s discharges rapidly through the diode. It should be noted that the value of C_s determines the amplitude of the saw-tooth, but not its duration, which is fixed by that of the rectangular driving pulse.

58. The sawtooth waveform is fed via C101 and RV38, the sweep length control, to the grid of V4, Type CV.127, which, with V5, Type CV.2127, forms a floating paraphase circuit providing two identical sweep outputs of opposite polarity for driving the cathode ray tube deflector plates X1 and X2. Both plates are DC-restored by double-diode V6, Type CV.140; the cathode of the half connected to the X1 plate is returned to the slider of a potentiometer RV.49 X SHIFT connected across the HT supply.

Five-mile calibrator

59. This circuit consists of a cathode-coupled flip-flop circuit (*fig. 34*) using a double triode V7, Type CV.858. The circuit, triggered by the same pulse that triggers the sweep generator, produces a pulse about $1390\mu s$ long which is applied to the suppressor of V9, Type CV.138. This valve is connected as an R–C phase-shift oscillator and produces a sine wave output at 16.3 kc/s. RV14, in the cathode circuit of V9, gives fine control of this frequency. The gating wave applied to the grid G3 of V9 is DC-restored by V17, Type CV.1092, and so the oscillator is switched on for a period equivalent to a range of 120 miles each time the monitor is triggered. The 16.3 kc/s sine wave output from V9 is fed into a two-stage zero-bias amplifier V10 and V11, Type CV.138, which produces a square-wave output. The output of V11 is applied to a ringing circuit (L1, C72) connected in the grid circuit of a further zero-bias amplifier V12, Type CV.138. The cathode circuit of V12 is completed by the CAL switch (SW3) when this is at ON. The effect of the application of the square wave to the ringing circuit, and V12, is as follows:—

On the positive transitions the ringing circuit rings, but as the first half cycle is positive, grid current flows in V12 and the ring is damped out immediately, so the effect on the anode current is negligible.

On the negative transitions the circuit rings again but this time the first half cycle is negative and damping of the ring by grid current does not take place until the second half cycle, and a positive

pulse is produced at the anode. The output at the anode is a train of positive pulses at a repetition frequency of 16.3 kc/s. These positive pulses are applied to the Y2 plate of the CRT when the CAL switch is on and one of the 50, 100 or 250-mile ranges are selected. As the oscillator is gated by a pulse of $1390\mu s$ duration on the 250 mile range, calibration markers up to about 120 miles only, will be displayed.

2 μs calibrator

60. A high speed multivibrator V13, Type CV.138, and V14, Type CV.138 (*fig. 34*) is used to produce the 2 μs calibrator markers. V13 is switched on the suppressor by V7 (using the same pulse as that applied to G3 of the R–C oscillator V9). A choke L2 is connected in the cathode circuit of V13. This choke rings when V13 is cut off and produces a positive pulse across itself, the remainder of the ring being damped out by the diode V8B connected across it and which conducts as soon as the voltage across the choke reverses. This pulse is applied to the Y2 plate of the CRT, as before, when the 2.5 miles range is selected.

Display circuits

61. The display circuits are conventional, and employ electrostatic deflection and focusing CRT Type CV.1385 which has a short persistence green screen. An EHT supply of approximately 3 kV is obtained from the associated power unit 876, the positive side of the supply being earthed. Operating potentials for the various electrodes are obtained from the potentiometer chain connected across the supply. The sensitivity of the CRT is 27V per mm.

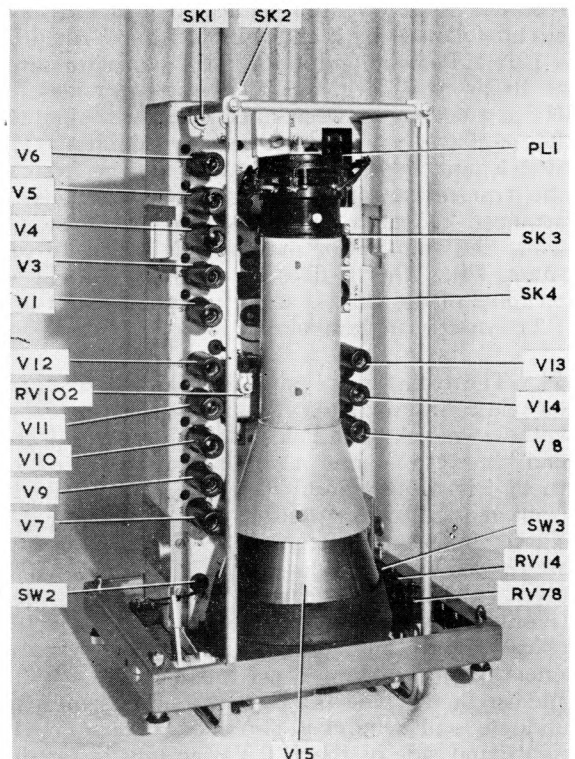


Fig. 13. Monitoring unit Type 82—top chassis view

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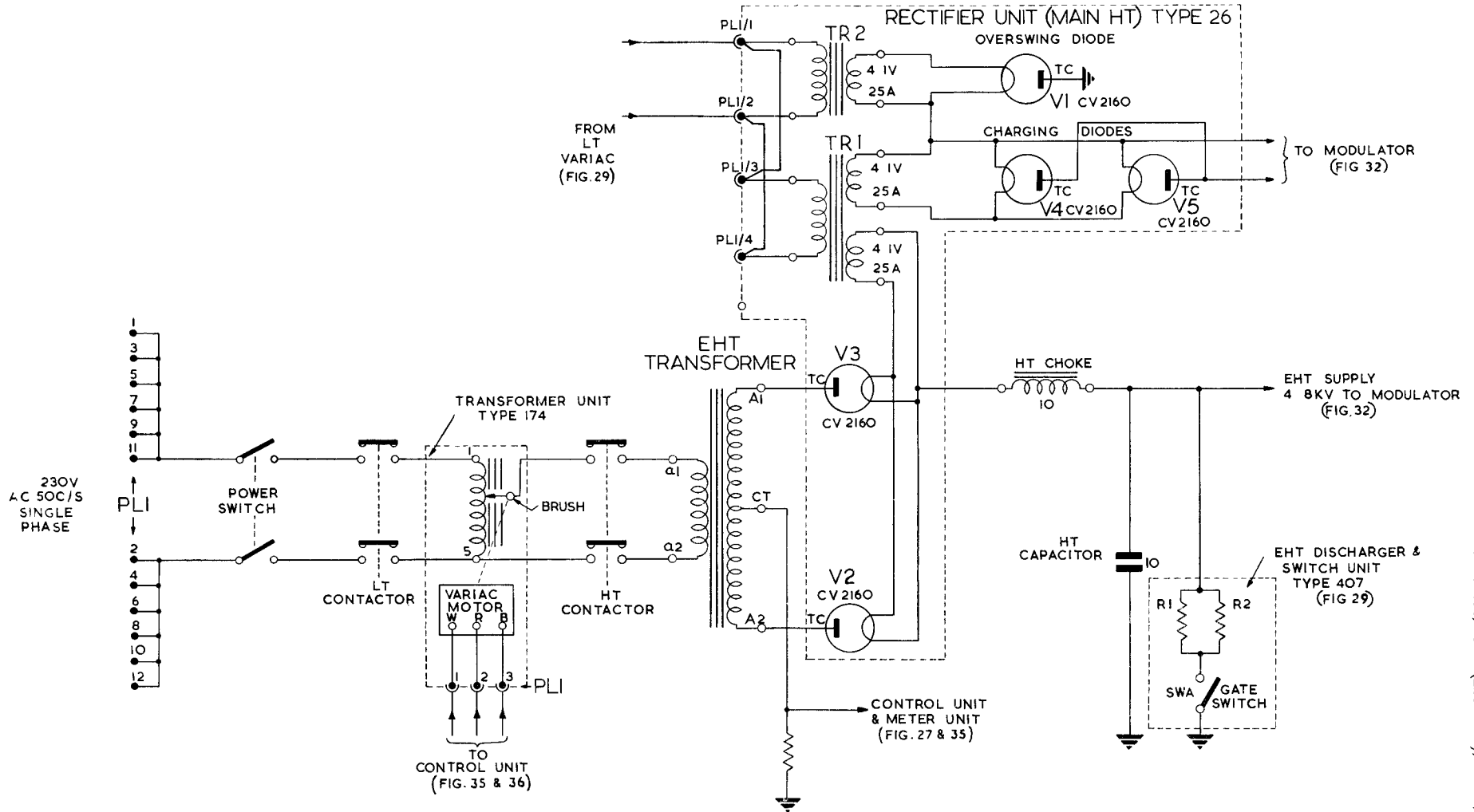


Fig. 15. Main EHT power supply—circuit

VALVE BASES
V1-V5 ON RECTIFIER
UNIT TYPE 26 ARE
FITTED WITH GIANT
EDISON SCREW BASES
WITH THEIR ANODES
CONNECTED TO TOP CAPS

1	3	5	7	9	11
2	4	6	8	10	12

PLI (ALL UNITS)
LOOKING ON PINS

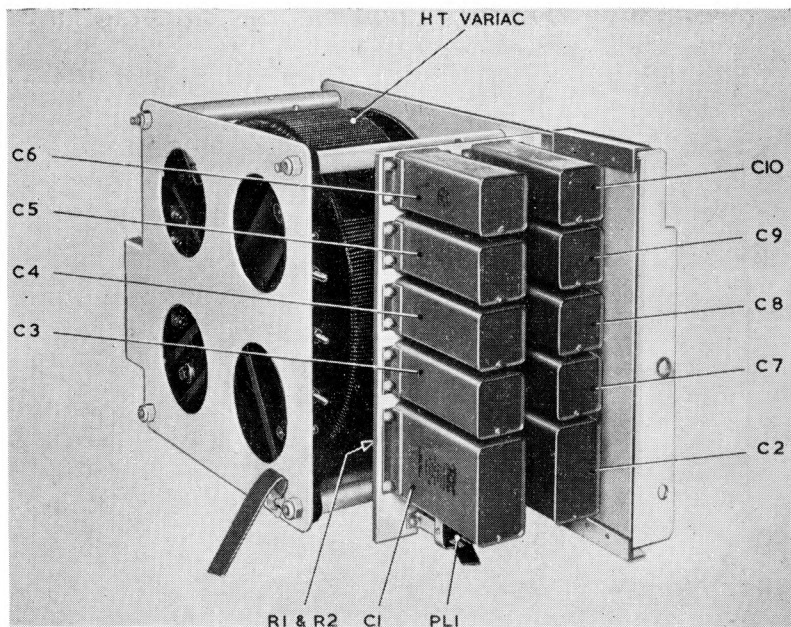


Fig. 16. Transformer unit Type 174 (showing capacitor assembly)

member of the transmitter frame just above it. Special tools provided with the transmitter are required for removing the transformer.

Note . . .

An earthing rod, with a 5 ft. long lead attached to the transmitter framework, is hooked on the side of the transmitter; this rod should be used to check that when the transmitter is switched off, the parts of the circuit it may be required to handle are discharged.

Auxiliary power units

67. All HT and LT supplies, with the exception of the main HT supply and the heaters supplies for the RF oscillator, discharger unit and main rectifier unit are obtained from three auxiliary power units. The auxiliary power units are supported on telescopic runners by L-shaped brackets in the top of the left-hand compartment. The units are secured to these runners by latches, at the front and the rear of the chassis, which engage in the tops of these brackets. These latches are secured by threaded studs and stiffnuts. All the chassis are of the same size, measuring 17 in. deep, 9 $\frac{3}{4}$ in. wide and 12 in. high, overall. The units slide into place on the runners and are kept closed by two knurled nuts, fitted with clamping screws screwing on to studs on the transmitter cabinet.

68. The HT capacitor, mounted in the centre compartment behind the discharger unit, is held in place by two metal straps, tightened by screws, and also by special clamps between the top of the capacitor and the frame of the transmitter.

69. The power unit (trigger) Type 877 is the bottom, left-hand unit of the three auxiliary power units in the top of the left-hand compartment of the transmitter. It has a single full-wave circuit (fig. 18) using a full wave rectifier Type CV.575 fed from a 450-0-450V secondary winding on a mains transformer, and supplies up to 150 mA. The power supply uses a single stage capacity input filter and feeds a Stabilovolt STV/280/40A. Three

stabilized outputs are available from the Stabilovolt, plus a 70V negative bias supply which is fed to the main thyatron. Only one of the stabilized supplies is used, the +210V supply which is used to feed the amplifying unit (IF) Type 301 on the trigger unit 2. An output of about 550V is obtained from across the reservoir capacitor and fed to the small thyatron on the discharger unit as its HT supply. Two of the capacitors on the sub-assembly of the HT Variac unit are connected across this supply to provide additional smoothing.

70. The power unit (monitor) Type 876 is the top right-hand unit and has two separate power supply circuits on it. One is a full-wave circuit, fed from a 350-0-350V winding on a mains transformer, with a single-section, choke-input filter. The rectifier is a Type CV.575. This circuit supplies a normal 350V supply at 250 mA to the monitoring unit

Type 82 via an additional smoothing network on the capacitor sub-assembly on the transformer unit 174. The second circuit provides a 3 kV, 3 mA negative supply for the CRT in the monitor unit and a 4V AC supply for the CRT heater. A half-wave rectifier Type CV.261 is mounted under the chassis on an insulating bracket and is connected to the 3 kV winding of a mains transformer. This is followed by a single stage capacitor input, resistance-capacitance filter. A 9M bleeder network (R2-R10) mounted inside a paxolin tube is connected to the EHT supply under the chassis and discharges the smoothing capacitors when the supply is switched off.

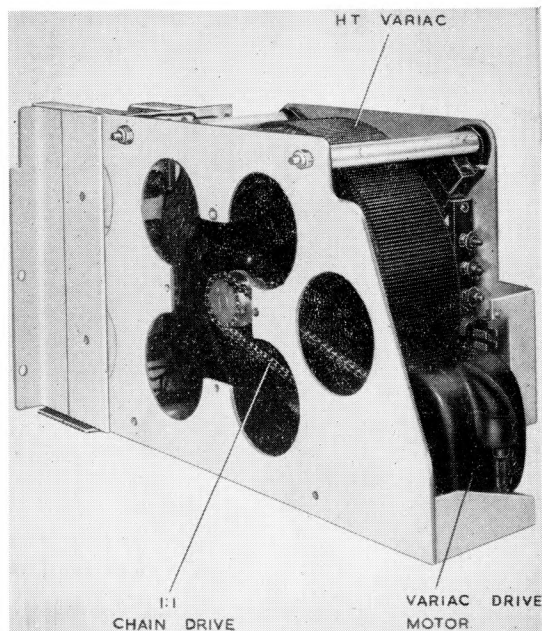


Fig. 17. Transformer unit Type 174 (showing HT Variac)

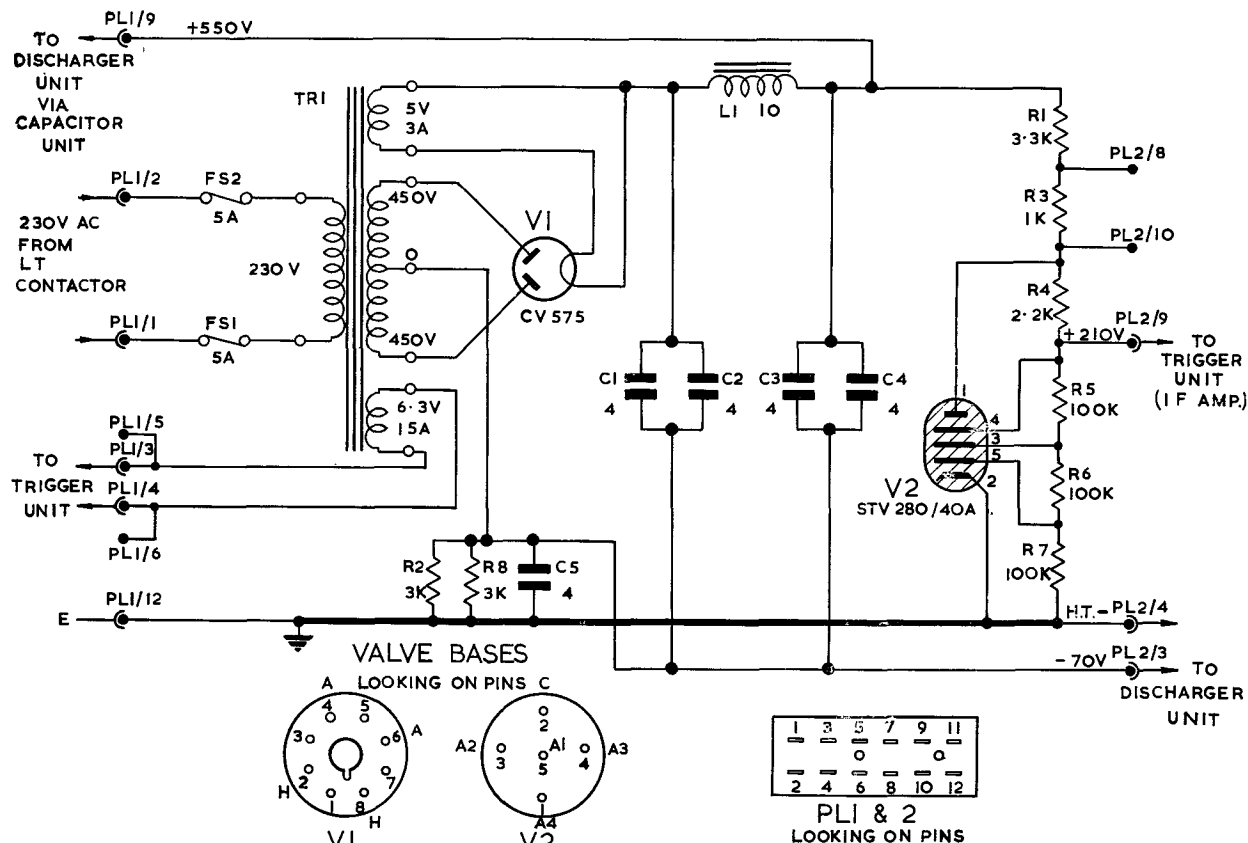


Fig. 18. Power unit (trigger) Type 877—circuit

71. The power unit Type 878 is the bottom right-hand unit of the three units and provides a 350V, 250 mA supply for the trigger unit Type 2 (excluding the IF amplifier) and a 50V, 4A supply for the automatic control circuits of the transmitter. A 350-0-350V secondary winding of transformer TR1 feeds a full-wave rectifying circuit using a valve Type CV.575 followed by a single section capacity input smoothing filter. Further smoothing in the supply to the trigger unit is provided by a capacitor resistor network on the front of the HT Variac unit. Mains transformer TR2 feeds a selenium bridge metal rectifier MR1 (mounted under the chassis) which feeds a choke input filter, the output being 50V, 4A.

72. The power unit (heaters) Type 887, is mounted, with the pulse forming network, on telescopic runners in the rear of the RF oscillator compartment and supplies valve heater current to the RF oscillator only, providing an AC output of 16V at 16A for this purpose. Also mounted on this unit are two diodes Type CV.1092. One of these rectifies the heaters supply voltage for metering purposes while the second performs a similar function on the mains supply voltage.

73. An LT Variac supplies the primaries of the transformer which provide heater and filament supplies to:—

(1) The RF oscillator (transformer on the power unit Type 887)

(2) The thyratrons on the discharger unit (two filament transformers on the discharger unit).

(3) The five high voltage rectifiers on the rectifier unit (main HT) (two filament transformers on the rectifier unit)

The LT Variac is mounted at the rear of the left-hand (or power supply) compartment and is accessible when the small panel on the rear of the transmitter is removed. The Variac is immersed in an oil-filled case and rated at 200-240V, 1.73 kVA, single phase input (50 c/s nominal) and provides an output of 230V at 5A. The Variac case is fitted with a non-spill pressure relief valve.

Switch unit 407

74. The switch unit 407 consists of two mechanically interlocked controls located directly below the control unit and marked GATE and POWER respectively.

The GATE control is purely mechanical in operation and has two functions:—

(1) In the *ON* position it locks the cubicle doors and secures the withdrawable units in the middle bay. If any unit is partially withdrawn when the GATE control is turned *ON* the unit can be pushed in and then will be locked in position, automatically.

(2) In the *OFF* position it earths the main smoothing capacitor via a limiting resistor and connects the pulse forming network directly to earth. The POWER switch controls the 230V AC supply to the transmitter and is interlocked with

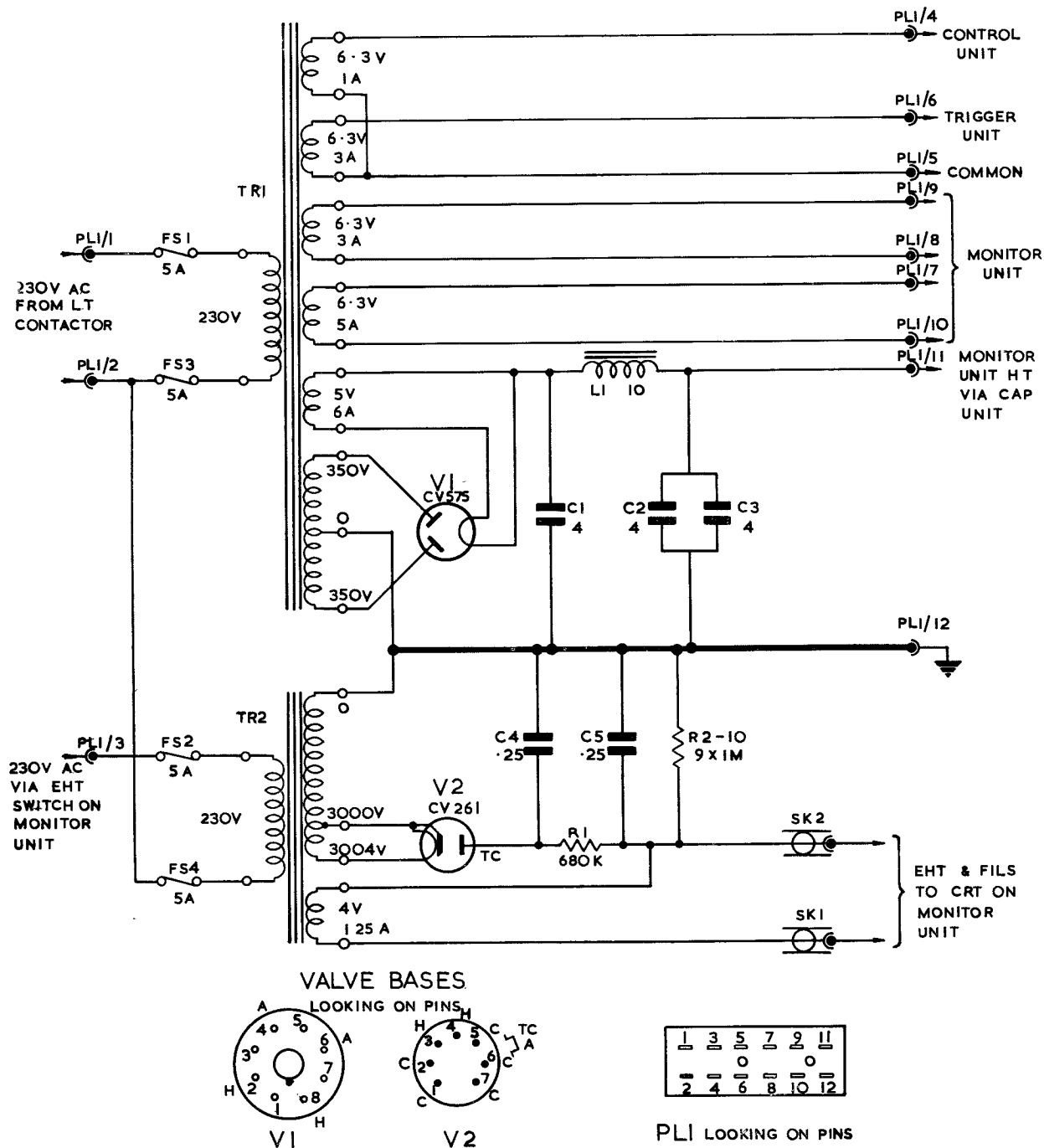


Fig. 19. Power unit (monitor) Type 876—circuit

the GATE switch so that it cannot be closed till the GATE switch is at *ON*, and it must be put to *OFF* before the GATE switch can be opened. This ensures that under normal operation the risk of lethal electric shock is reduced to a minimum.

75. When servicing the transmitter it is sometimes necessary to test or adjust units during operation and for this reason the interlock system is designed so that the transmitter can be switched on with the doors opened and units withdrawn.

WARNING

When working with the transmitter in this manner extreme care must be taken to avoid accidental

contact with any of the supplies, especially the main HT, or any part of the charging circuit. The transmitter must not be left in this condition without proper supervision, even for a short period.

CONTROL UNIT TYPE 616

76. The control unit Type 616 (fig. 24, 25, and 35) provides the automatic control facilities for the transmitter. It is mounted in the middle compartment of the transmitter between the trigger unit Type 2 and the switch unit Type 407 and comprises a chassis 21 in. long with a front panel 12½ in. wide and 10 in. high. Its method of mounting and fastening is similar to that of the trigger unit.

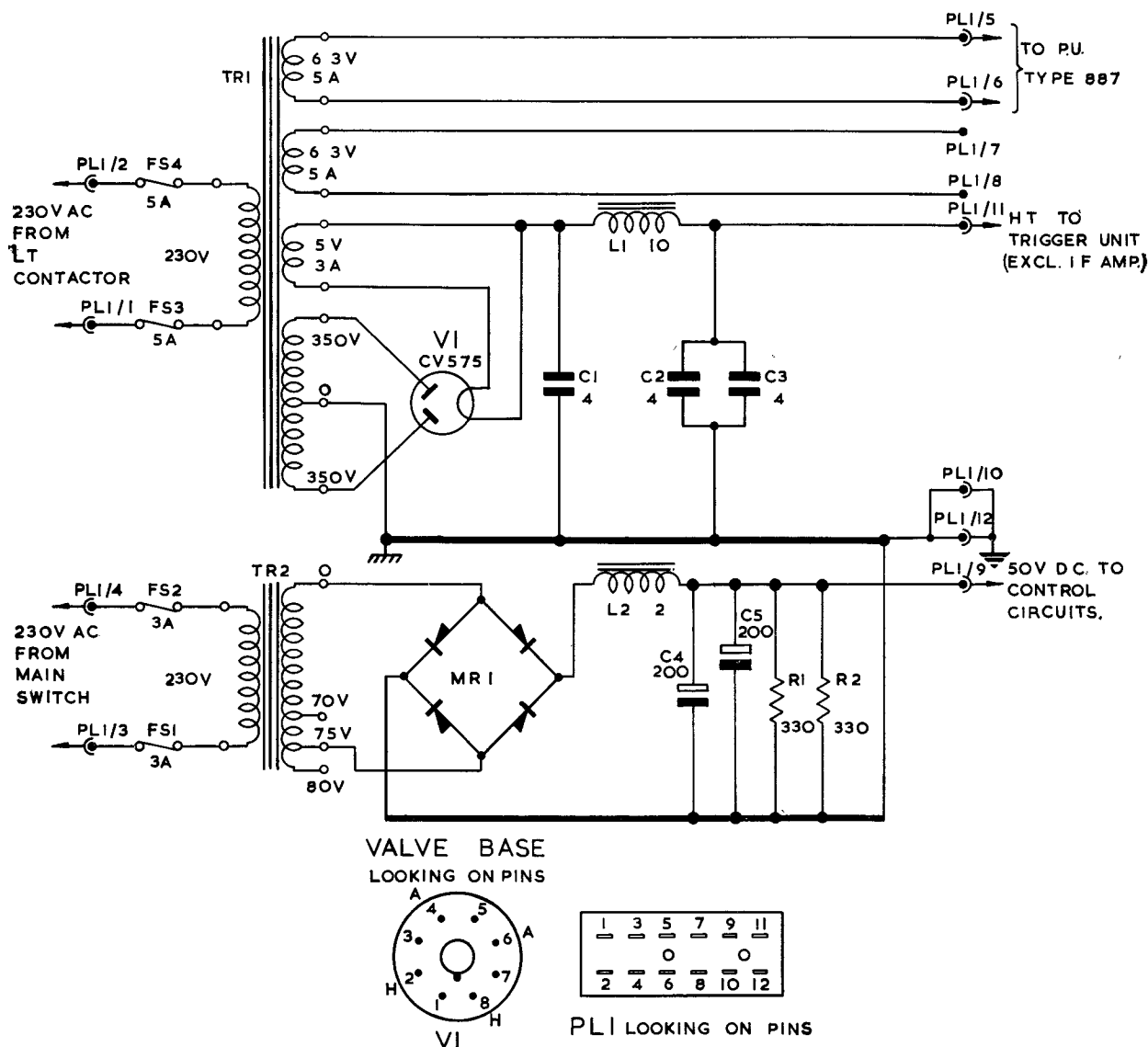


Fig. 20. Power unit Type 878—circuit

Controls

77. On the front panel are mounted three controls, of which two are associated with the automatic control circuits (*fig. 36*).

They are:—

(1) The HT setting control (RV2). This variable resistor controls the current through V3 and so determines the HT voltage at which relay RLM will operate.

(2) The HT RESET button (SW2). This switch breaks the cathode circuit of V3 so that relay RLM releases. It also operates relay RLG so that the Variac motor drives the HT voltage down. RLG will only be energized as long as the button is pressed (*para. 95*).

The third control is a switch labelled SEL. 1, SEL. 2 and is not used when the control unit Type 616 is part of transmitter T.3705.

78. There are also three preset controls on the unit, all associated with the automatic control circuits. Two are accessible through holes at the top of the front panel and are:—

(1) HT down limit setting (RV1), which controls maximum current flowing in V2 and so determines minimum HT voltage setting (that is, voltage at which relay RLD operates).

(2) Overload setting control (RV3), which determines HT current at which the over current relay RLA will operate (*para. 92*).

The third control is mounted on the top of the chassis and is the HT up limit setting (RV4), which controls the maximum current flowing in V3 and so determines the maximum HT voltage attainable by adjustment of RV2.

79. Also on the front panel of the unit is an hour meter which is connected across the AC circuit feeding the power units which supply the RF

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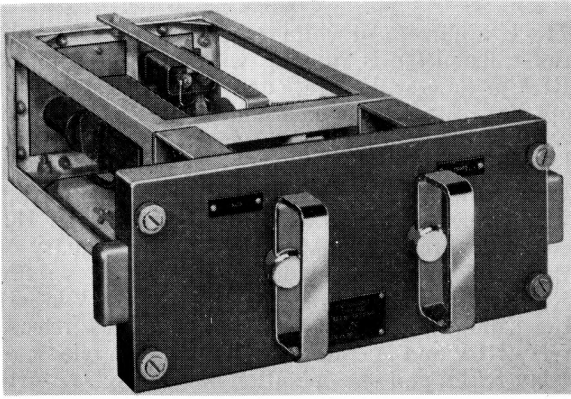


Fig. 23. Switch unit Type 407—general view

The operating coil is of 2000Ω resistance. Two of the relays (RLJ and RLK) are not used in the T.3705.

Stabilovolt circuit

82. On the chassis is a valve holder for a stabilo-volt with the associated circuit. The circuit is not used in this application of the control unit.

Automatic control circuits

83. All the components in the automatic control circuit are mounted on the control unit Type 616, with the exception of the LT, HT and fan contactors, the air pressure switch, the HT Variac motor and the DC ON, FILS ON, HT ON and HT UP lights. The LT and HT contactors are mounted in the left-hand compartment of the transmitter just beneath the auxiliary power units while the HT Variac motor is mounted on the transformer unit Type 174 in the top left-hand portion of this compartment. The indicator lights are arranged in a row along the top of the transmitter while the fan contactor and air pressure switch are on the fan assembly Type 26.

84. When the POWER switch on the front of the transmitter is closed, the 230V AC supply is fed to the 50V DC power pack (on power unit Type 878) and to the LT contactor, which is open. The 50V supply is fed to the operating circuit of the relay

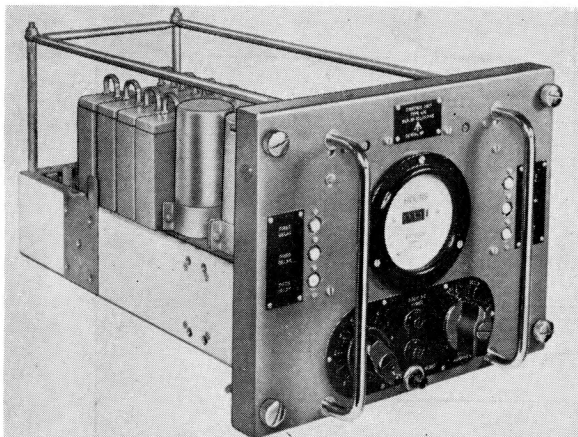


Fig. 24. Control unit Type 616—general view

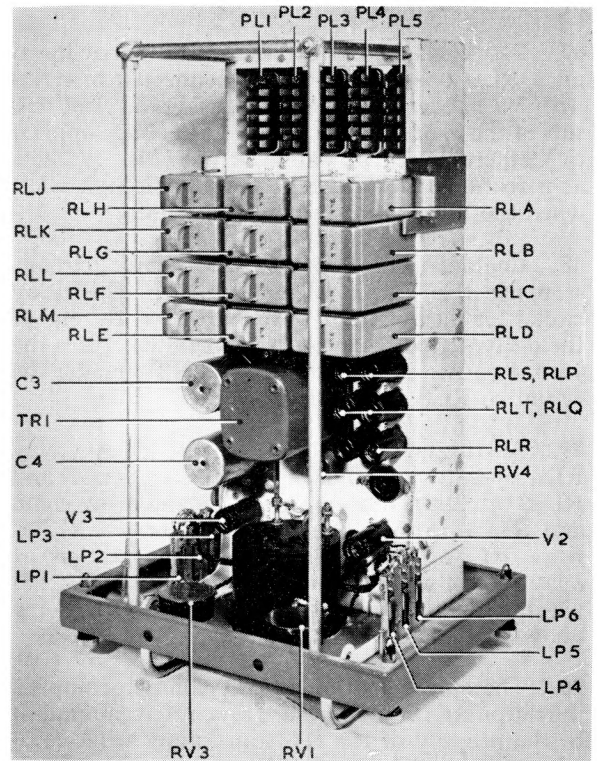


Fig. 25. Control unit Type 616—top chassis view

RLH and the LT and fan contactors, which do not operate because the ON button must be operated to complete their operating circuits. The DC ON lamp, which is mounted on the top of the transmitter, lights as it is connected across the 230V AC supply.

85. When the ON button is pressed, relay RLH operates, and is held on by the circuit via RLH 4, the OFF buttons and contacts RLE1, RLA1. Contact RLH 3 makes the circuit to the fan contactor and as soon as the air blower is running, the air pressure switch closes and makes the circuit to the LT contactor operating coil. The LT contactor closes, contacts LT1, LT2 applying AC to the fans and power units (including RF oscillator heaters) and the HT Variac. The FILS ON lamp lights. This AC supply also energizes a transformer which feeds a delay chain of five thermal delay switches which are connected in cascade to give a total delay of about 260 seconds. Each delay switch consists of a bimetallic strip and heater mounted in an evacuated glass envelope on a D7G base.

86. The contact LT3 of the LT contactor closing applies the 50V DC to the remainder of the relay circuits. Relay RLG (the motor run-down relay) is operated via the break contact HT4 of the HT contactor and RLF1. If the HT Variac is not at minimum there will be insufficient voltage across V2 to operate relay RLD and so the operation of RLG completes the supply to the down winding of the HT variac motor by RLG3 and RLG4 (via RLD1, RLM1). At the same time contact RLG2

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breaks the circuit of the HT ON lamp to prevent it lighting and RLG1 breaks the circuit of RLF (the motor run-up relay).

87. The Variac motor drives the HT Variac down until RLD operates. RLD is connected in series with V2 between the slider of the Variac and one side of the mains supply so that the voltage applied to V2 increases as the Variac output falls. V2 acts as a rectifier, most current flowing through RLD when the Variac is at minimum setting.

88. Contact RLD1 breaks the motor circuit, stopping the Variac, RLD3 prepares the delay circuit for the operation of relay RLC at the end of the delay period while contact RLD4 energizes the VARIAC DOWN lamp (LP4). RLD2 breaks the circuit to RLB and RLL (*para. 92*).

89. At the end of the 260 second delay, relay RLC operates and holds via RLC3. RLC1 and RLC2 break the heaters supply for the delay chain and RLC4 operates the HT contactor via RLB1, relay RLB being unoperated. Energization of relay RLC also lights the RUNNING UP lamp (LP5) via the break contact RLL2, relay RLL being unoperated.

90. The operational of the HT contactor applies the output of the HT Variac (which is at minimum) to the primary of the HT transformer while HT4 releases relay RLG and HT3 operates relay RLF (the motor run up relay). RLF1 breaks the operating circuit of relay RLD which releases. RLF3 and 4 complete the energization of the Variac motor which drives the Variac up, increasing the HT. RLG 2 lights the HT ON lamp and RLD2 prepares the operating circuits of relay RLB and RLL for operation. When the HT reaches a value determined by the setting of RV2 and 4 the current through V3 operates relay RLM. RLM1 breaks the Variac motor circuit, RLM3 lights the HT UP lamp while RLM2 removes a shunt across relay RLM and so ensures that the relay will not release until the HT reset button is pressed. RLM4 operates relay RLL which holds via RLL3. RLL 4 shorts out RLA1 and RLE1 so that RLH will not immediately release if an overload occurs. Contact RLL2 breaks the circuit to the RUNNING UP lamp (LP5) which extinguishes.

91. Over-current and over-voltage relays are provided on the transmitter. The over-current relay RLA in series with a preset variable resistor RV3, is connected across a resistor connected in the earth return lead from the centre tap of the EHT transformer secondary, and operates if the mean HT current exceeds 500mA. The over-voltage relay RLE is fed from a spark gap connected to the anode of the main thyatron on the Discharger unit. If the voltage at this point is excessive the spark gap breaks down and the current through relay RLE

is sufficient to operate it and so to switch the HT off.

92. If a current or voltage overload occurs while the transmitter is running with full HT applied RLA or RLE will operate and RLA4 or RLE3 will operate relay RLB which holds via RLB4. RLH will not release as it holds via RLL4, relay RLL having operated when full HT was reached. RLB1 breaks the operating circuit of the HT contactor which releases. Contacts HT1, HT2 of the HT contactor breaks the AC supply to the primary of the EHT transformer and this de-energizes relay RLM which is fed from this supply via V3. At the same time, contacts HT3 and HT4 release relay RLF and operate relay RLG. The release of relay RLM, and the operation of relay RLG starts the Variac motor which drives the Variac down until relay RLD operates at the minimum HT setting; this stops the Variac motor with contact RLD1 and releases relays RLB and RLL with contact RLD2. The release of the HT contactor would have released relay RLA or RLE, whichever had operated, so relay RLH will be held by contacts RLA1 and RLE1 when relay RLL releases, opening RLL4. The release of RLB will re-energize the HT contactor operating relay RLF and so the HT Variac will start to run up again as before (*para. 90*).

93. If an overload occurs during the time the HT is running up either when the transmitter is first switched on or during the period immediately following an overload, relays RLA or RLE will operate before relay RLM has operated. As RLM has not operated, relay RLL will not have operated and so relay RLH will release when the overload occurs because contact RLL4 will not be closed. This means that the entire transmitter will switch off except for the 50V DC supply.

94. Thus, if a permanent fault occurs, the transmitter will automatically shut down, but if an isolated overload occurs, the transmitter will automatically reset itself.

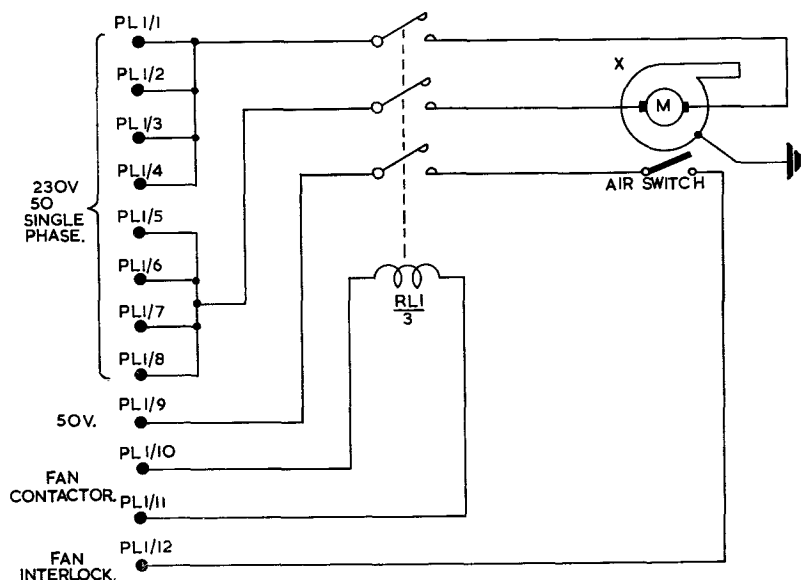


Fig. 26. Fan assembly Type 26—circuit

HT level setting

95. If it is desired to alter the HT voltage while the transmitter is operating it is done as follows:—

- (1) If the HT is to be raised turn the HT setting control clockwise to the new setting, then press and release the HT RESET button when RLM will release and the Variac motor will drive the HT voltage up until RLM operates again.
- (2) If the HT is to be lowered turn the HT setting control anti-clockwise to the new setting then press the HT RESET button until the HT falls to below the new value; the button should be released and the Variac motor will drive the HT up until RLM operates again.

Adjustment of the HT setting control will determine the HT setting at which RLM will operate. If the HT is to be raised RLM will not release when the control setting is changed, as the shunt across the relay was disconnected by the operation of contact RLM2. As soon as the HT RESET button is pressed, relay RLM releases and, as relay RLF is already operated, the release of relay RLM will energize the Variac motor which will drive the HT up until the current through RLM is sufficient to operate it again. If the HT is to be lowered to a new setting, the automatic HT setting circuit will not operate until the HT voltage has been lowered below the new value. When the HT RESET button is pressed, RLM releases and RLG is energized, releasing RLF. The Variac motor will drive the HT Variac down until either the button is released or relay RLD operates at minimum HT setting. When the HT RESET button is released, as long as the HT is then less than the desired value, RLF will operate and the Variac motor will drive the HT Variac up until RLM operates. The HT will then be at the new setting.

Fuses

96. It should be noted that the fuses on the control unit Type 616 fuse the 230V AC circuits on the control unit. The symptoms resulting from one to both of the fuses blowing will vary with the instant at which the fuse blows. That is,

(1) If the fuses blow during the switching-on period before the HT has come on (that is, before relay RLC has closed),

- (i) The delay chain will be de-energized and the delay lights will go out.
- (ii) The Variac will stop (if it has not already reached the minimum HT position).
- (iii) The FILS ON light will go out.
- (iv) The auxiliary power supply units and the filaments and heaters of the various valves will stay on.

(2) If the fuses blow during the period when the HT is running up,

- (i) The Variac will stop.
- (ii) The FILS ON and HT ON lamps will go out.
- (iii) The transmitter will operate on reduced HT until it is switched off. (1) above will then apply when it is switched on again.

(3) If the fuses blow after full HT has been reached.

- (i) The FILS ON, HT ON and HT lamps will go out.
- (ii) The transmitter will continue to operate at full HT until it is switched off. (1) will then apply when it is switched on again.

Thus, if these fuses fail while the transmitter is in use, the changing of them can be left until the transmitter is switched off again. Alternatively, it is possible to replace the fuses while the equipment is still operating but in this case care should be taken not to come into contact with any live portion of the fuse or fuse holder.

LEFT-HAND DOOR**Meter circuit**

97. Voltage and currents at various test points can be measured by means of a microammeter and a selector switch mounted on the left-hand door of the cabinet. The meter multiplying factor is always a multiple or sub-multiple of ten, so converting meter readings to actual current or voltage values is a simple matter.

98. The meter M1 is a 0–500 μ A DC 3 $\frac{1}{4}$ in. moving coil instrument and, with the selector switch SW1, is mounted on a panel on the front of the door. The voltage multiplier R1–R8, and a crystal MR1 are mounted on a tag board inside the door and the meter circuit is connected to the transmitter

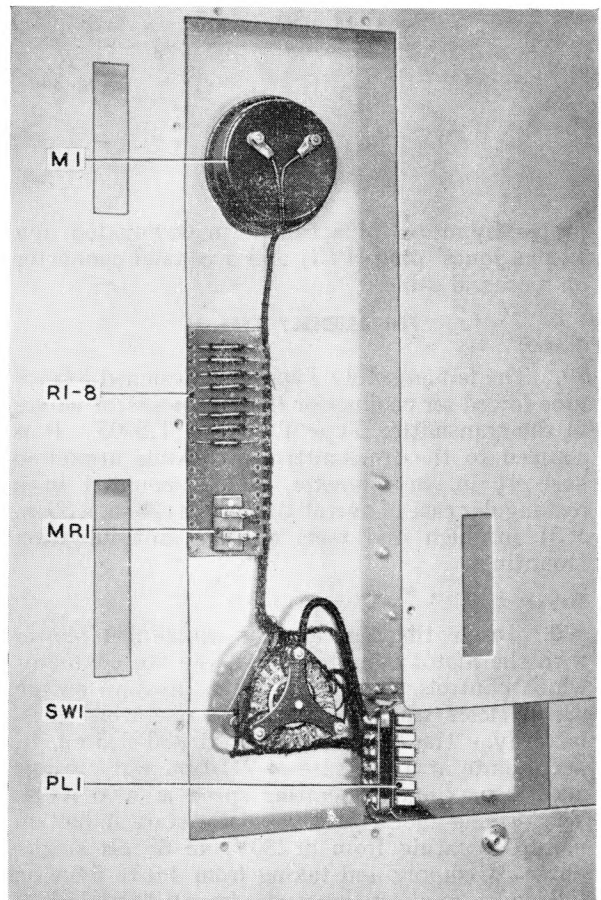


Fig. 27. Test meter unit—rear view

(A.L.10, Oct. 56)

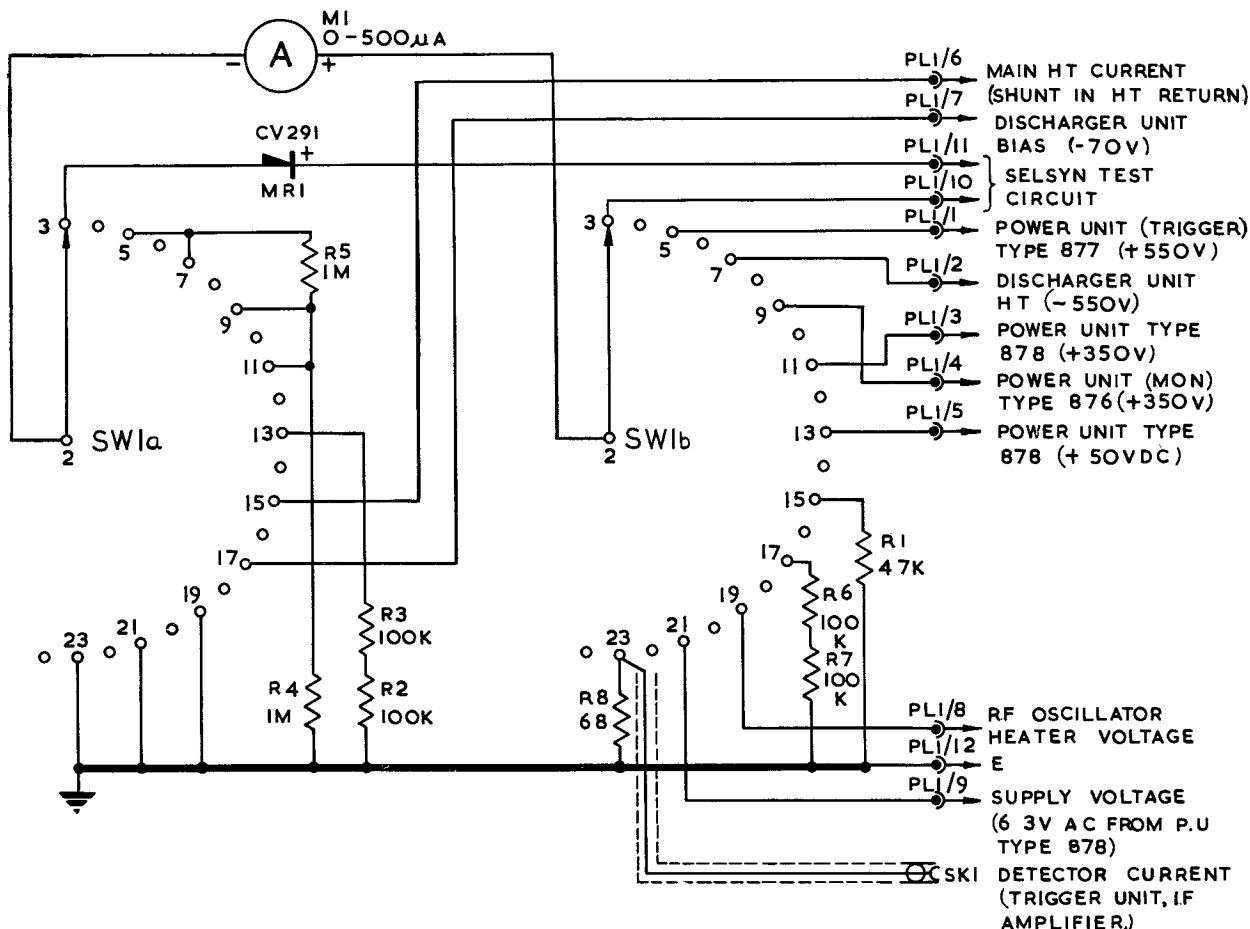


Fig. 28. Test meter circuit

proper by means of a cableform terminated in a 12-pin Jones' plug (PL1) and a coaxial connector on a coaxial cable.

FAN ASSEMBLY TYPE 26

General

99. The fan assembly Type 26 is designed to provide forced air cooling for the RF oscillator valves in the transmitter Type T.3692 or T.3705. It is coupled to the transmitter by flexible armoured hose $4\frac{1}{2}$ in. in diameter. It is mounted in a rectangular case of overall dimensions 28 in. $\times$ 30 in. $\times$ 31 in. high and rests on four anti-vibration mountings.

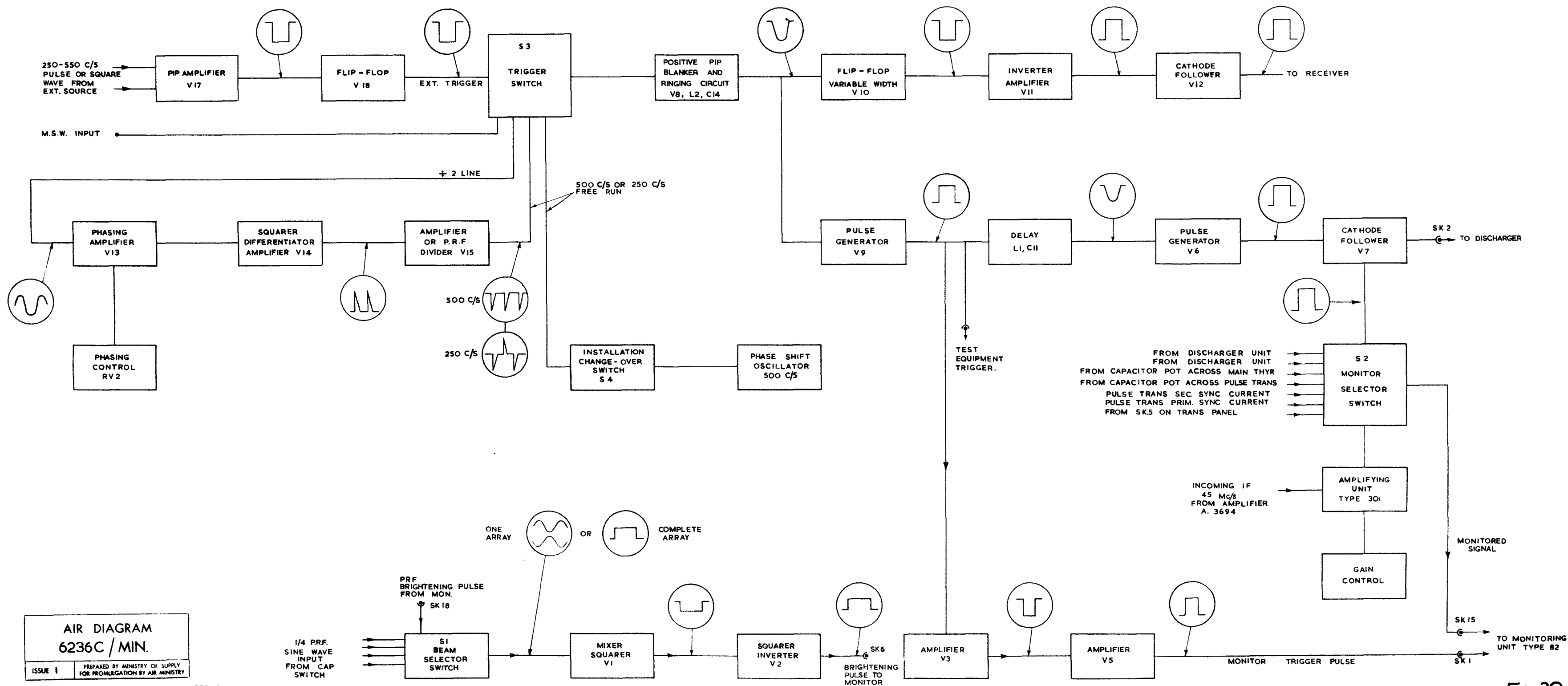
Blower

100. Inside the case are the centrifugal blower with the motor mounted on it, the fan contactor which controls the motor and a pressure switch which closes when the blower is operating satisfactorily. The blower is rated at 380-565 cu. ft. per minute at a pressure of 7-10 in. water gauge and its maximum operating speed is 3700 RPM. The driving motor is a capacitor-start induction motor operating from a 230V, 45-65 c/s single-phase AC supply and taking from 4.0 to 5.8A on full load. Power rating varies from 0.4 to 1.18 h.p. and RPM from 2250 to 3700 depending on the supply frequency.

Air filter

101. On one side of the case a Visconol air filter assembly is mounted. This filter assembly is held in place by four screw clamps and two spring clips. It is readily removable first by slackening and then turning the clamps, finally depressing the two springs and pulling out. All the air to the blower is drawn in through this filter, thus ensuring that the air fed to the valves for cooling is dust-free. The filter can be cleaned, readily, by washing in lead-free petrol and then immersed in oil OM-36 (Stores Ref. 34D/100547).

102. The air pressure switch is of simple, trouble-free design and requires very little air to operate it. A floating piston is mounted inside a cylinder. Air is admitted to the underside of the piston which is forced up by the air pressure. Mounted on the end of the cylinder is a pair of make contacts. A pin on the lower spring protrudes through a hole in the end of the cylinder and when the piston rises it forces the pin up, completing the circuit to the fan contactor. The contactor is similar to the LT and HT contactors inside the transmitter. It is rated at 50V operating voltage and has 8800 turns with a resistance of about 300 ohms.



Trigger unit Type 2 — block diagram

Fig. 30

(AL10, October 1956.)

AIR DIAGRAM
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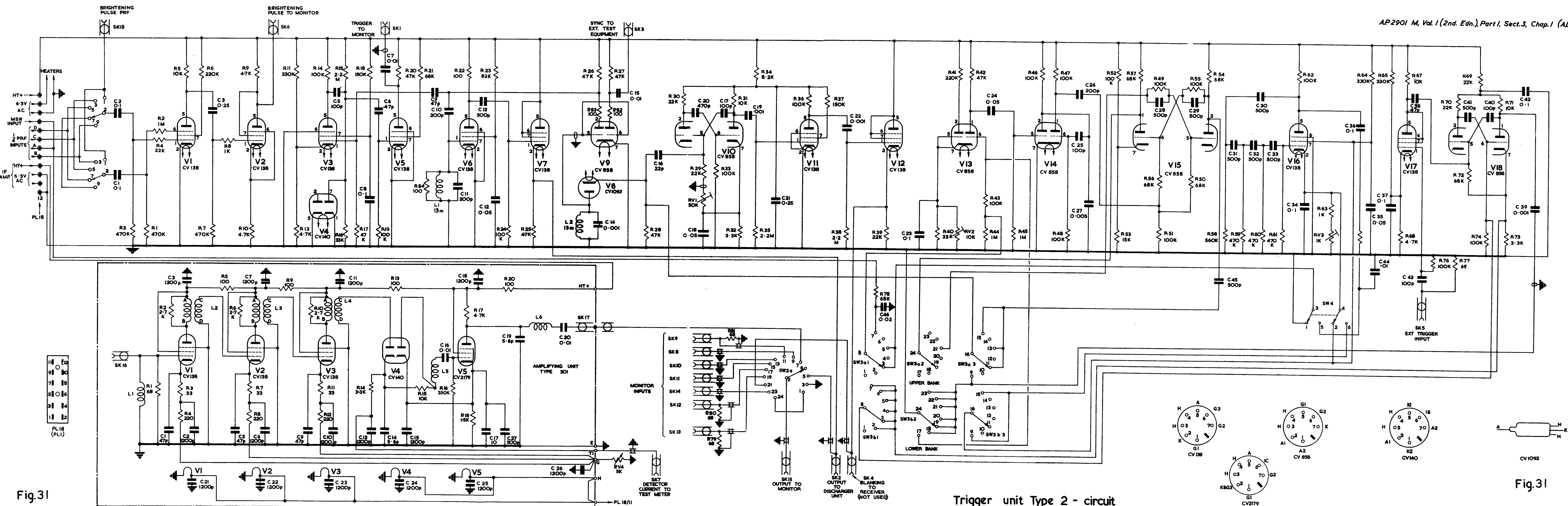


Fig.31

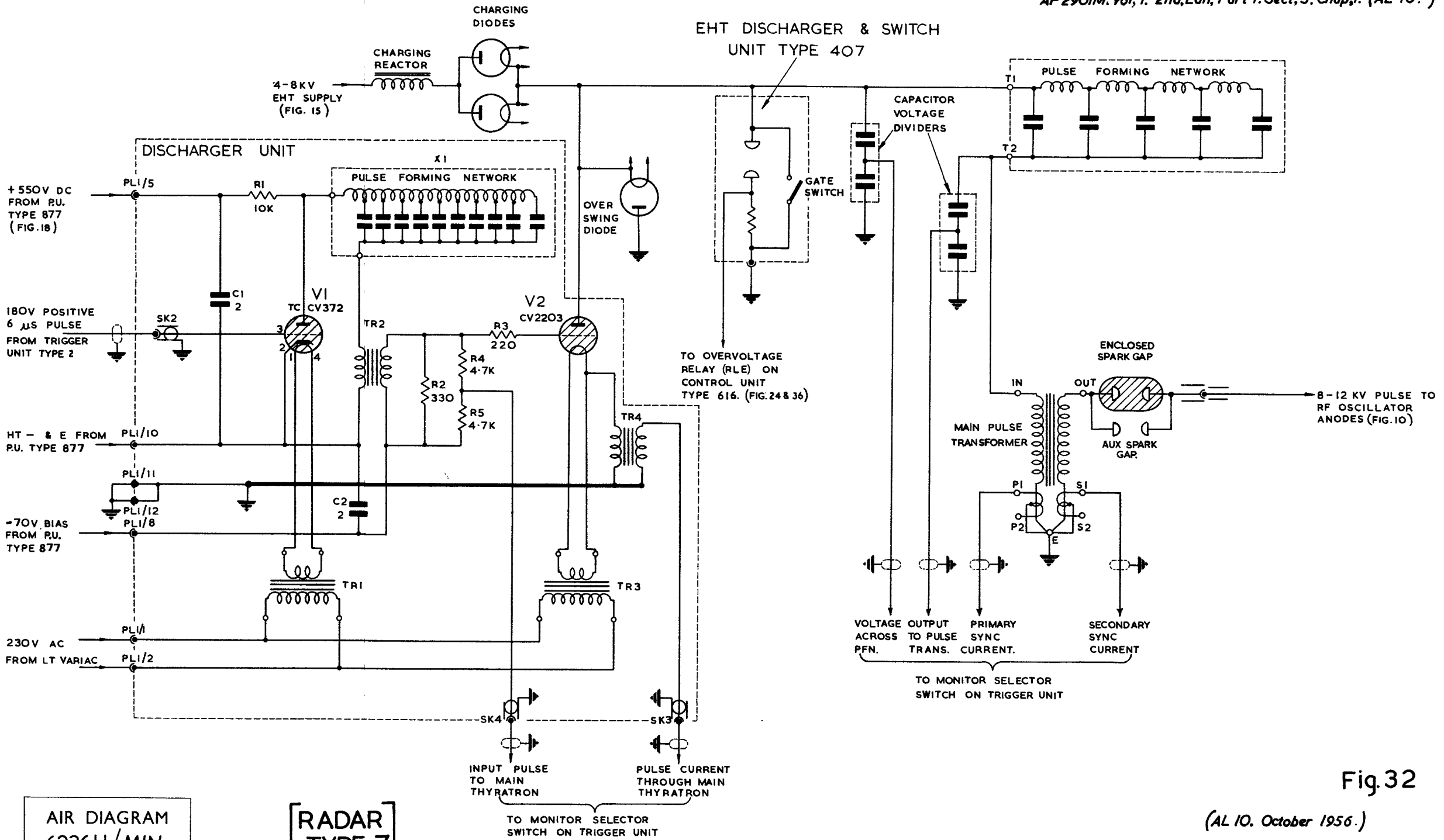
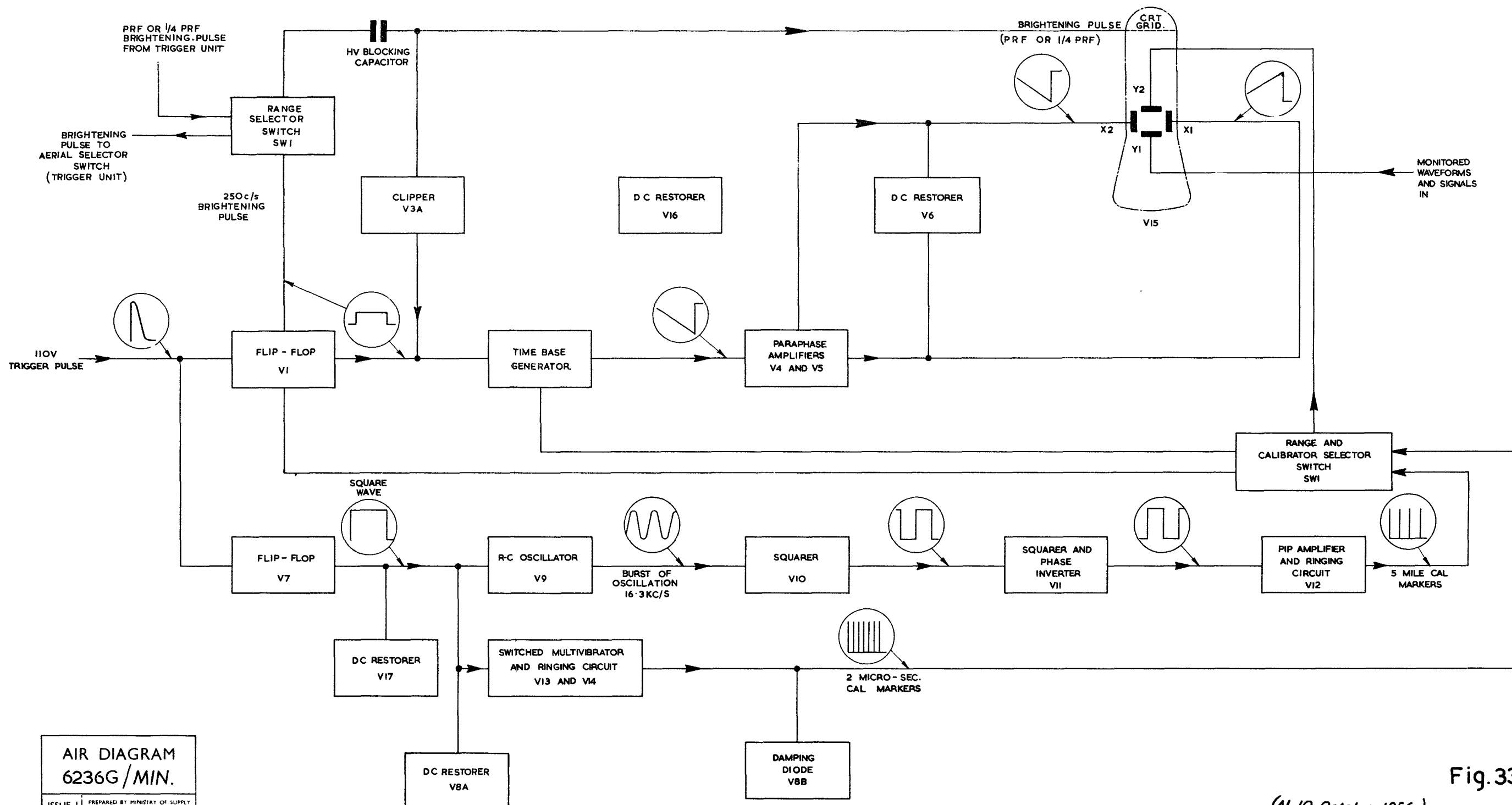


Fig.32

(AL 10. October 1956.)

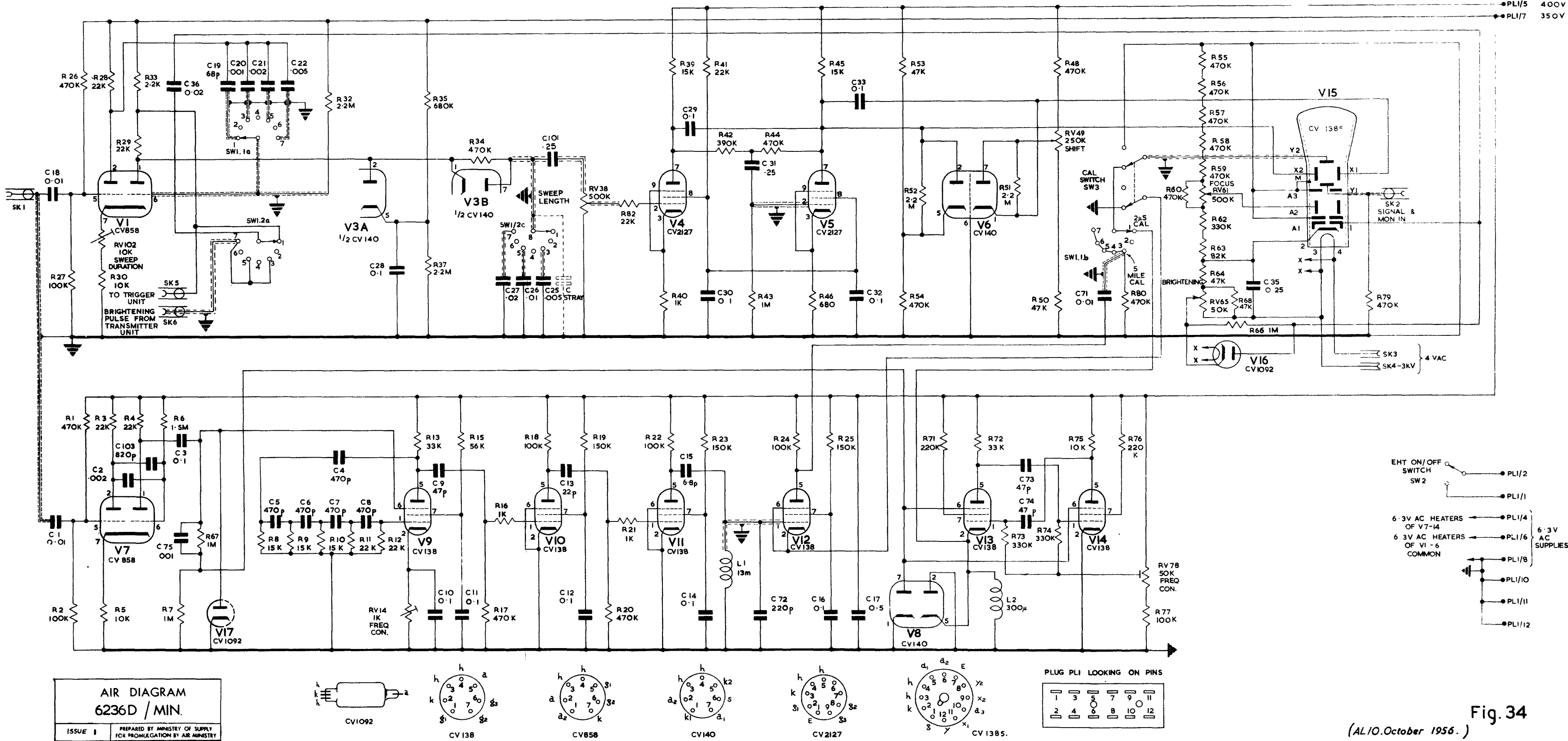
High and low level modulator-circuit



Monitoring unit Type 82 - block diagram

Fig.33

(AL10 October 1956.)



Monitoring unit Type 82 - circuit

Fig. 34
(AL10.October 1956.)

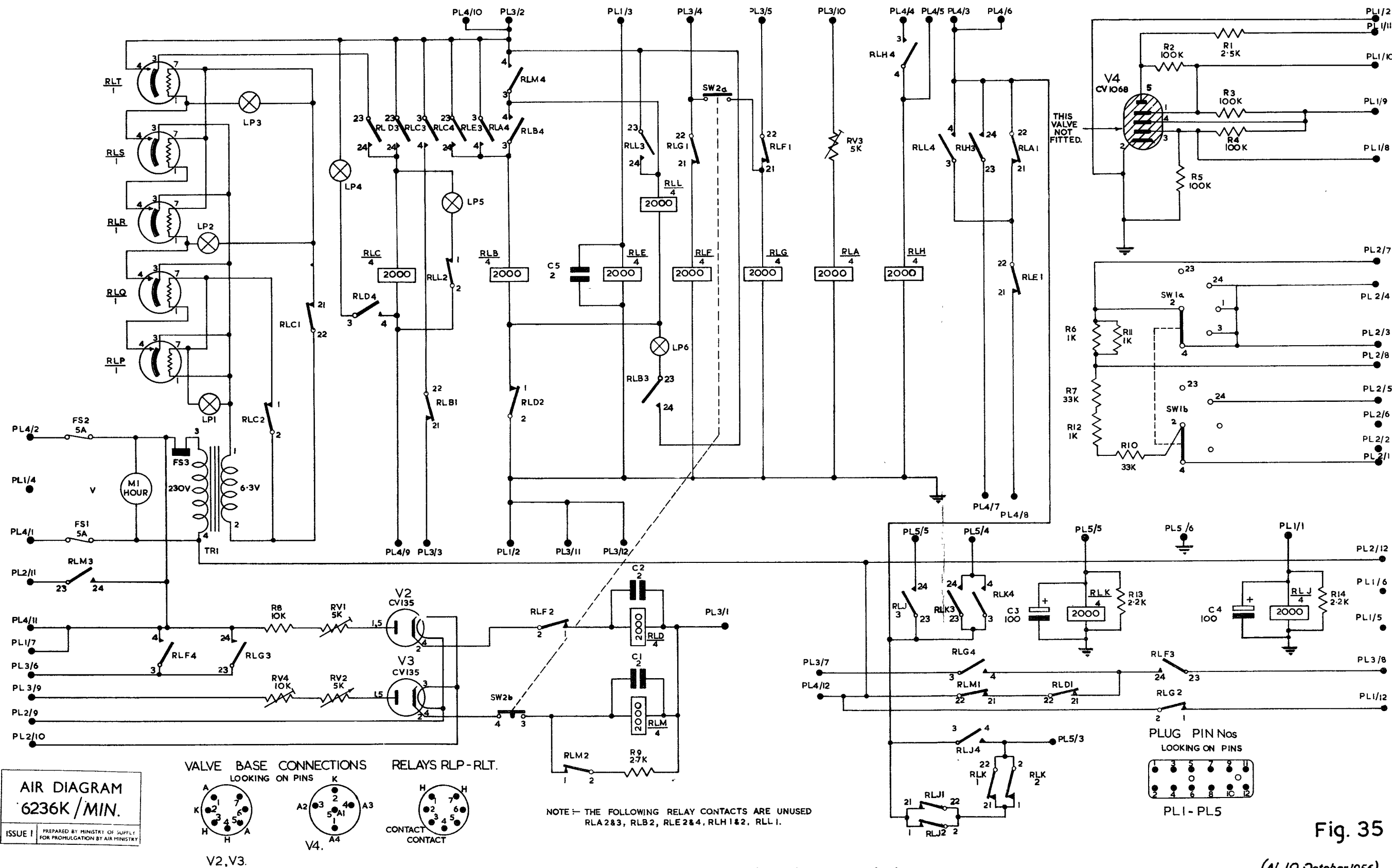
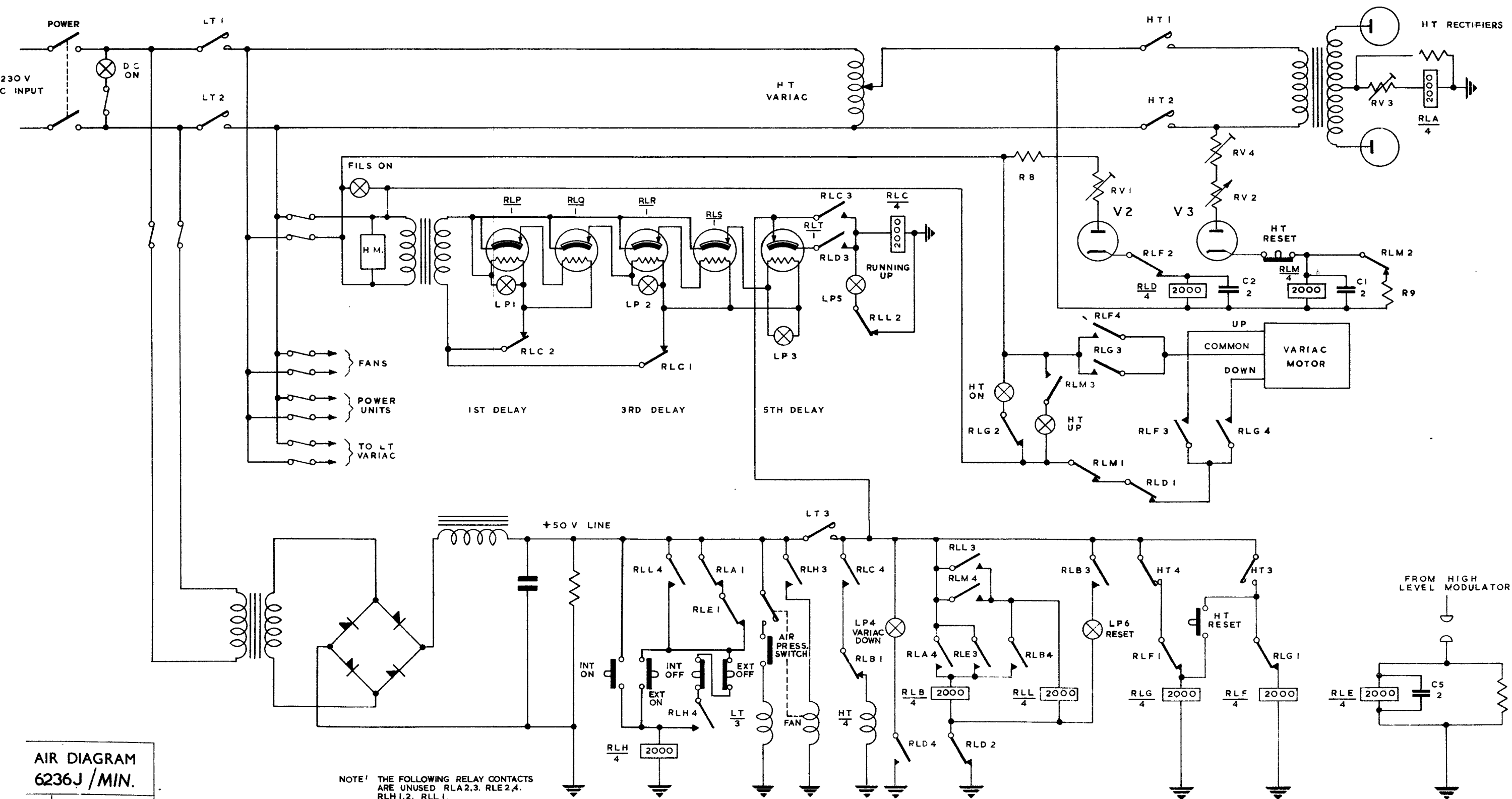


Fig. 35

(AL 10. October 1956)



AIR DIAGRAM
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[RADAR
TYPE 7]

Automatic control circuits

Fig. 36

(AL 10. October 1956.)

Chapter 2

RECEIVER (AMPLIFIER TYPE A.3694)

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Note.—Fig. 6 and 7 are also issued as miniature air diagrams MIN AD6236A and B

GENERAL DESCRIPTION

1. Amplifier Type A.3694 (*fig. 1*) consists of a receiver and its associated power supply unit contained in a wall-mounting steel cabinet. The dimensions of the cabinet are $24\frac{3}{4}$ in. high $\times$ $26\frac{1}{2}$ in. wide $\times$ $7\frac{3}{4}$ in. deep.
2. The front of the cabinet is hinged to provide access to the internal units, and is secured by two coin-slotted screws at the top of the front cover. The inside lip of the front cover is aluminium sprayed; when the cover is closed this surface makes contact with serrated strips of tin-plated beryllium-copper fixed round the front lip of the cabinet. This provides an efficient electrical contact to ensure good screening.
3. Gauze-covered ventilation holes are provided in the top and bottom of the cabinet. The top also carries four coaxial sockets through which connections to the input and output circuits of the amplifier are made, and a 6-pole Mk. 4 plug through which the mains supply is connected to the power unit.

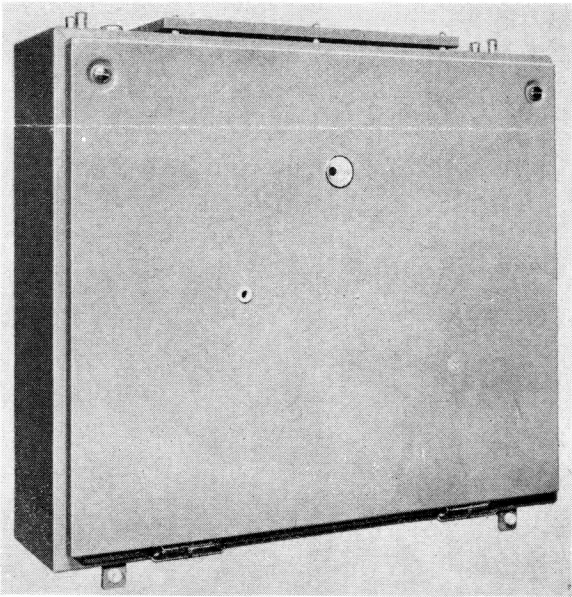


Fig. 1. Amplifier Type A.3694—exterior view

(A.L.6, April 56)

4. The amplifier, an interior view of which is shown in fig. 2, consists of the following units:—

- (1) Amplifying unit Type 299.
- (2) Amplifier (IF) Type A.3691.
- (3) Power unit Type 886.

5. The two amplifiers are bolted together and mounted in the lower half of the cabinet. The upper half of the cabinet houses the power unit.

Amplifying unit Type 299

6. A general view of the amplifier assembly is shown in fig. 3.

7. The amplifying unit consists of an RF amplifier, a mixer stage and a local oscillator. Its function is to amplify received RF pulses and convert them to an intermediate frequency of 45 Mc/s.

8. The amplifying unit measures approximately $10\frac{1}{2}$ in. long $5\frac{1}{2}$ in. wide $\times$ $5\frac{1}{2}$ in. deep and weighs 4 lb. The valves are mounted on the upper side of the chassis. The tuning capacitors are fitted with slow motion dials for tuning purposes; these give a two speed drive and are self-locking.

9. The underside of the chassis is divided into compartments to ensure effective screening between the stages and is fitted with a removable baseplate. An efficient electrical connection between the baseplate and the chassis is maintained by spring contact fingers.

10. The unit operates from a HT supply of 210V, DC, and has a current consumption of 27.5 mA; a LT supply of 6.3V AC at 1.2A is required for the valve heaters.

Amplifier (IF) Type A.3691

11. This is a five-stage IF unit used in the present application to amplify the IF output from amplifying unit Type 299. The amplifier has a mid-band frequency of 45 Mc/s and a bandwidth of either $3.4 \text{ Mc/s} \pm 0.3 \text{ Mc/s}$ or $1.1 \text{ Mc/s} \pm 0.2 \text{ Mc/s}$ at 3 dB down; the bandwidth is selected by a switch (SW1). The overall gain of the amplifier is 60 dB at 3 dB with a bandwidth of 3.5 Mc/s, and $63 \text{ dB} \pm 3 \text{ dB}$ with a bandwidth of 1 Mc/s. The amplifier has a noise factor of less than 1.8 (2.5 dB).

12. The overall gain of the RF and IF amplifiers which switched to 'Narrow bandwidth' is $86 \text{ dB} \pm 3 \text{ dB}$ with a bandwidth of 0.8 Mc/s at 3 dB down. The noise factor is less than 4.5.

13. The underside of the chassis is fitted with screening covers to ensure effective screening. An efficient electrical connection between the chassis and the covers is maintained by spring contact fingers.

14. The unit operates from a HT supply of + 210V DC, and has a current consumption of 55mA; a LT supply of 6.3V AC at 1.5A is required for valve heaters.

Power unit Type 886

15. The power unit (*fig. 4*) is mounted on a chassis of inverted L section; a metal grille is fitted to the underside of the chassis to prevent accidental contact with components mounted beneath the chassis. The overall dimensions of unit are $23\frac{1}{2}$ in. long $\times$ 11 in. high $\times$ 7 in. deep and the weight is 42 lb.

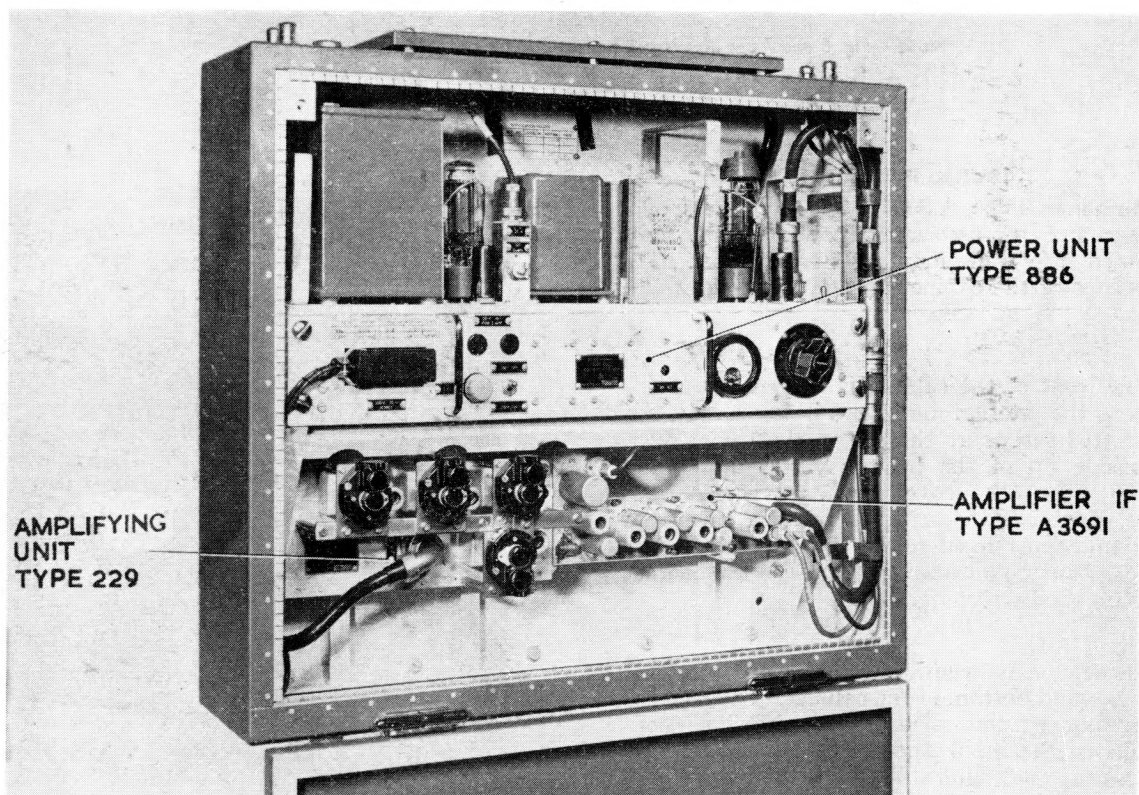


Fig. 2. Amplifier Type A.3694—interior view

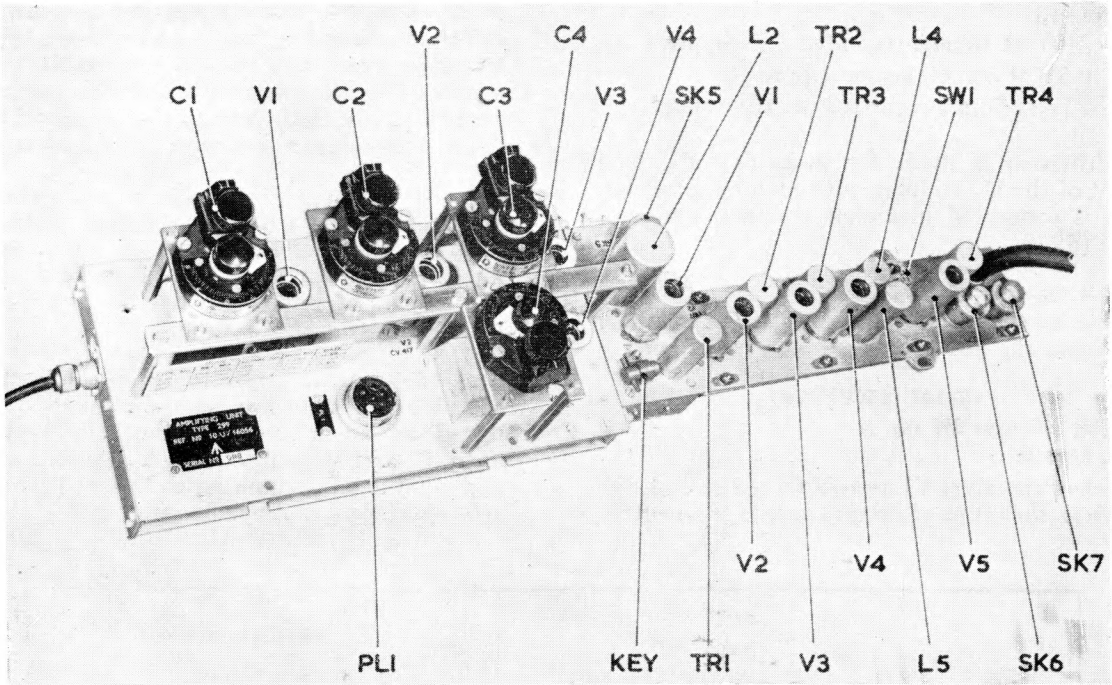


Fig. 3. RF and IF units—top chassis view

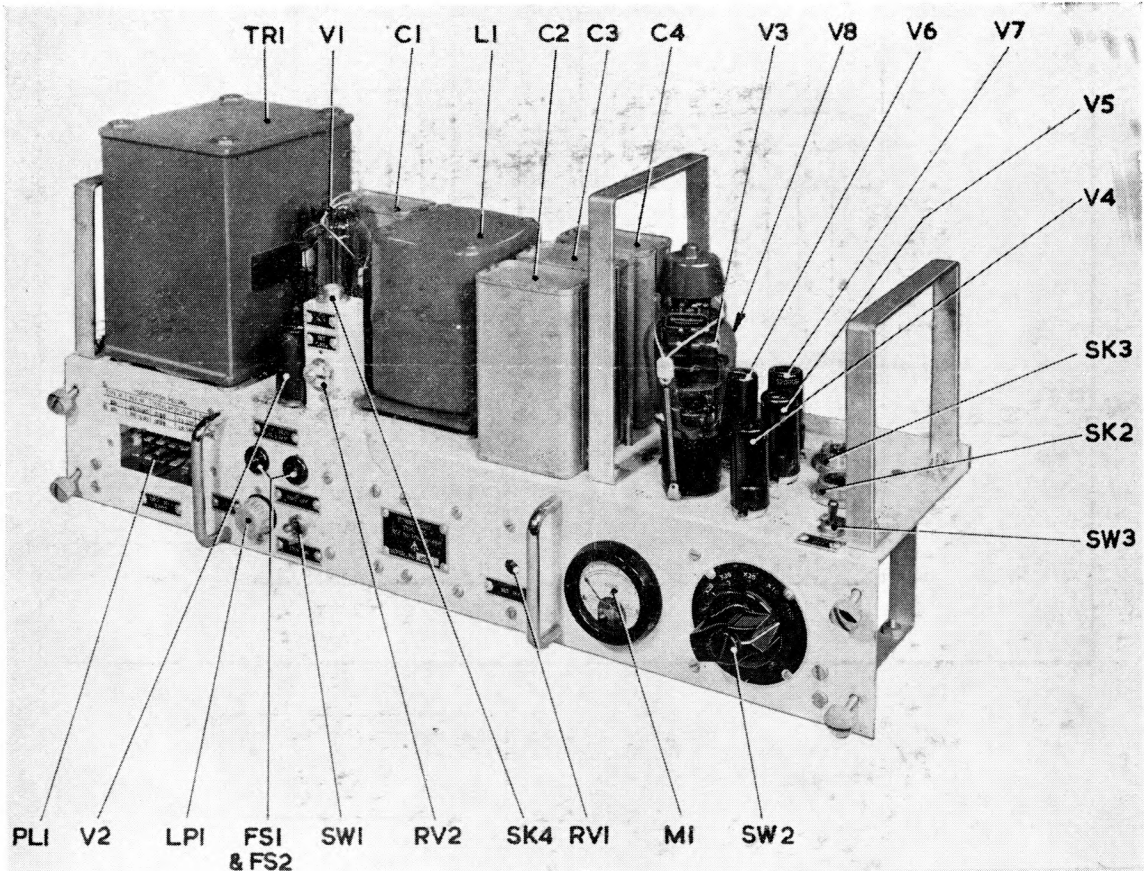


Fig. 4. Power unit Type 886—general view

16. The unit operates from a 230V 50 c/s single-phase supply and delivers the following output voltages:—
- (1) 210V at 150mA regulated HT supply.
 - (2) 6.5V at 5A AC heater supply.
 - (3) 95V at 10mA regulated negative supply.

17. Provision is made for measuring the load current of the DC supplies with an internal meter, which is connected in circuit through a selector switch (SW2).

Inter-unit connections

18. Inter-unit connections between the amplifier proper and the power unit are shown in fig. 5.

CIRCUIT DESCRIPTION

Amplifying unit type 299 (fig. 6)

Cascode RF stage

19. The two valves V1 and V2 form a cascode RF amplifier. This type of circuit consists of a neutral-

ized triode amplifier (V1), the output of which is coupled to the input circuit of a grounded grid triode (V2). The cascode amplifier is widely used in VHF applications, the chief advantages being the low noise factor and the inherent stability of the circuit. The two triode valves have an overall gain approximately equivalent to that obtained from a single pentode stage but with a lower noise factor.

20. The reduction in noise is mainly due to absence of the partition noise that occurs in a pentode valve; stability is achieved by the damping imposed on the anode circuit of the first valve by the low input impedance of the grounded grid stage, and by neutralization.

21. The coaxial aerial feeder is connected via the plug PL3 to a tap, on the inductor L1, that represents an input impedance of 70 ohms so as to effect an impedance match between the aerial and input circuits; a mismatch here will give rise to errors in height-finding.

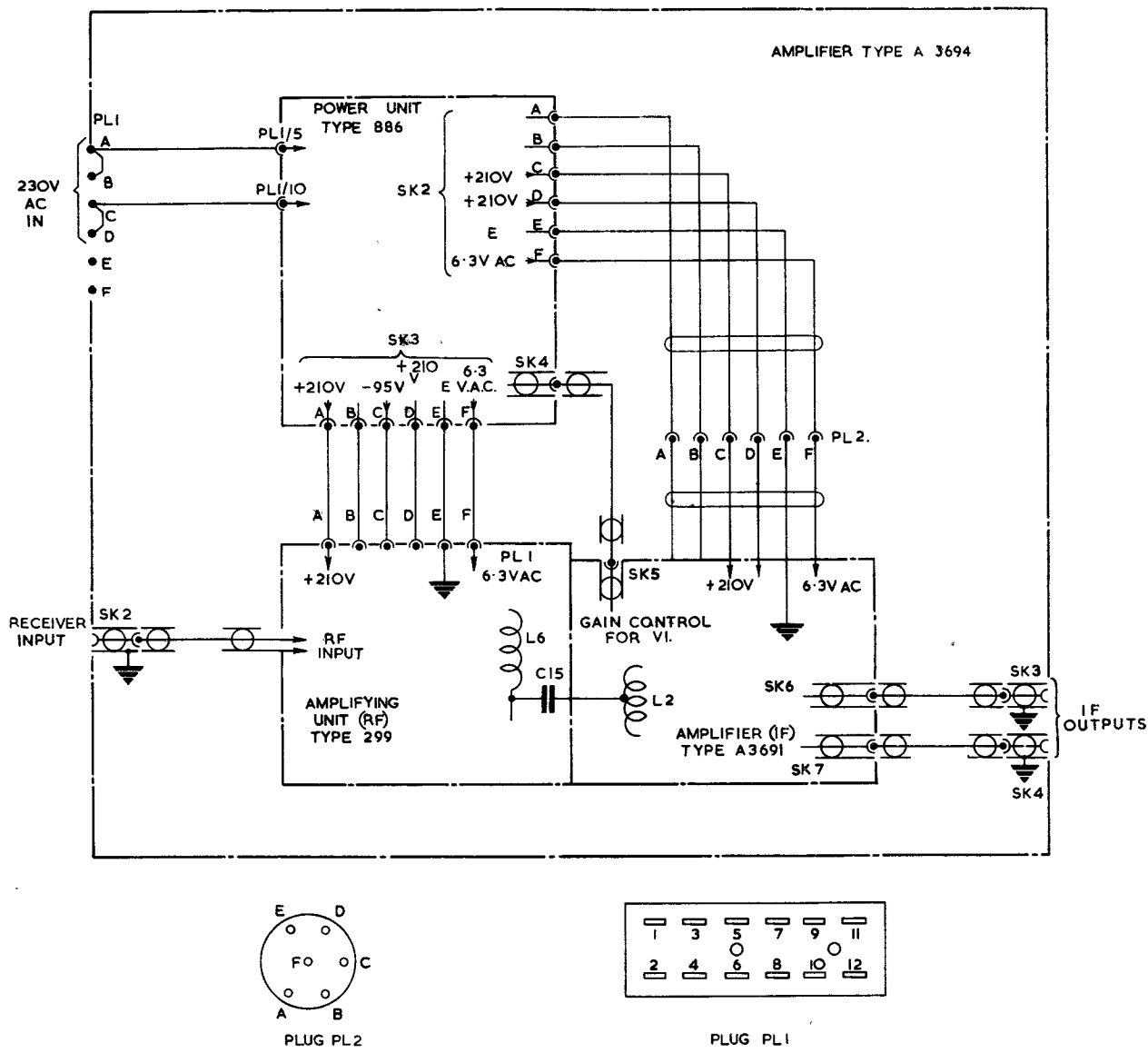


Fig. 5. Amplifier Type A.3694—inter-unit connections

22. L1 is parallel-tuned to resonance at signal frequency by C1; the voltage developed across the tuned circuit is applied to the grid of V1. Bias for V1 is derived from the cathode resistor R1, decoupled by C8.

23. V1 is neutralized by an inductor L2, in series with a DC blocking capacitor C5, connected between anode and grid. L2, and the grid-to-anode capacitance of the valve form a parallel-tuned circuit resonant at the mid-band frequency of the amplifier. The feedback from anode to grid is therefore negligible because of the high impedance of this tuned circuit. Neutralization also gives some improvement in noise factor due to reduction of induced grid noise.

24. HT is applied to the anode of V1 through R2; the HT supply line to V1 is decoupled by C6. The anode load of V1 consists of a parallel-fed network, formed by a centre-tapped inductor L3, tuned by a split stator variable capacitor C2. The network acts as a transformer with primary and secondary tuned. The primary is effectively connected between the anode of V1 and earth and the secondary between the cathode of the grounded-grid valve V2 and earth. C7 is a DC blocking capacitor and R13 improves the stability of first stage. C9 is an RF by-pass across the cathode resistor (R3) of V2. The DC cathode circuit of this valve is via R3 and one half of L3 to earth. The voltage drop across R3 is applied as cathode bias to V2.

25. A similar type of tuned circuit (L4, C3) is used as the coupling between the anode of V2 and the grid of the Mixer, V3 (para. 28). HT is applied to the anode of V2 through R4, which is connected to the centre-tap of L4. The HT line to V2 is decoupled by R5 and C10.

Local oscillator

26. The local oscillator employs a triode-connected pentode valve (V4) operating in a shunt-fed Colpitts circuit. The oscillator inductor L5 is tuned by the fixed capacitors C19, C20, C21 and the variable capacitor C4.

27. C19, C20 and C21 form a temperature compensating network which reduces the oscillator frequency drift to less than 50 kc/s for a temperature change from 20 deg. C to 70 deg. C. The HT supply is decoupled by R15 and C22 and applied to the anode of V4 through an RF choke L7. The oscillator operates on a frequency lower than that of the incoming RF signal, and its fundamental is used.

Mixer

28. The triode-connected pentode V3 functions as a mixer. Signal-frequency voltage developed across L4, C3, is applied to the mixer grid through C13 and local oscillator voltage is applied via C14. Bias is derived from the cathode resistor R8, decoupled by C16. The voltage developed across R8 is sufficient to bias the valve to the lower bend of its mutual characteristic; under this condition the mixer operates as a square-law detector.

29. The intermediate frequency (45 Mc/s) is the difference between signal and local oscillator frequencies. IF voltage in the anode circuit of the mixer is developed across the inductor L6, which is damped by R6. The output is taken from the anode via blocking capacitor C15, to a tap on the input inductor of the amplifier Type A.3691. The HT supply line to V3 is decoupled by C17.

HT and heater supply circuits

30. The HT supply connected to PL1/A is decoupled by C23 and R11. The supply to the valves V2 and V3 is further decoupled by R9 and C18. V1 obtains its supply from a separate circuit via a switch on the power unit labelled HT ON/OFF. This is used when neutralizing V1. The heater circuits of the valves are fed via separate leads from the supply plug and individually decoupled by the capacitors C25 to C28.

Amplifier (IF) Type A.3691 (fig. 6)

31. The output of the RF amplifying unit is connected to a 300-ohm tap on the input inductor L2 in the IF amplifier. The low-potential end of L2 is earthed to RF through C14. An RF filter consisting of L3 and C20 is connected between the earthy end of L2 and a coaxial socket SK5; this socket is connected to a preset bias circuit on the power unit (para. 50).

Cascode stage

32. L2 is broadly resonant at 45 Mc/s. The RF voltage developed across the inductor is applied to the grid of the triode V1. V1 and V2 function as a cascode amplifier (para. 19); in this instance, too, the neutralized triode V1 is transformer-coupled through TR1 to the grounded-grid triode V2.

33. TR1 is a bifilar-wound transformer giving unity coupling between the circuits and consequently has a response similar to that of a single tuned circuit. The transformer is permeability-tuned to resonate with its self-capacitance and stray circuit capacitances to 45 Mc/s; the low input impedance of V2 damps the transformer to give the desired wide band response. This type of transformer is employed to eliminate the need for a coupling capacitor.

34. Cathode bias for V1 and V2 is derived from the resistor R9 and R10 respectively, decoupled by C9 and C10. Grid bias for V1 is obtained from the GAIN control on the power unit and fed on to SK5.

Pentode stages

35. The cascode stage is followed by three pentode amplifiers, V3, V4 and V5. The anode circuit of V2 is coupled to the grid of V3 through a bifilar wound transformer TR2. In this instance the damping imposed by the grid circuit of V3 is insufficient to give the required bandwidth, and additional damping is introduced by R6 connected across the primary of TR2.

36. A similar type of coupling is used between V3 and V4. The anode load of V4 consists of either L5 parallel tuned by C21 and C22 or L4 damped by R8;

(A.L.6, April 56)

the particular tuned circuit is selected by the switch SW1. For normal use L5 is switched into circuit; this gives an overall bandwidth through the amplifier of 1 Mc/s, which is adequate for the reception of $4\mu\text{s}$ pulses. L4 is damped to such an extent that this circuit has a bandwidth of 11 Mc/s; when this inductor is switched into circuit the overall bandwidth through the amplifier is increased to 3.5 Mc/s.

37. The wide-band facility is intended for use primarily in receiving equipment employing automatic frequency control, should the AFC system fail. In the radar Type 7 installation the frequency stability of the local oscillator is such that the intermediate frequency is maintained well within the narrow passband of the IF amplifier; the wide band condition is not necessary in this application, and, if used, will result in some degradation in the signal-to-noise ratio of the receiving system.

38. The anode of V4 is capacitance-coupled via C8 to the grid of V5; R13 acts as grid resistor for this valve. The anode circuit of V5 is transformer coupled through TR4 to the parallel-connected output sockets SK6 and SK7. The output of the amplifier is high impedance and feeds two external 70Ω lines to external monitors and displays. The output circuit is correctly terminated when 70-ohm lines are connected to both SK6 and SK7, one line then acting as a termination for the other.

39. Bias for V3, V4 and V5 is derived from the cathode resistors R11, R12 and R14 respectively. The bias resistors are decoupled to RF by C11, C12 and C13.

HT and heater supply circuits

40. The HT supply to each valve is decoupled by the resistors R1 to R5 and the associated by-pass capacitors C1 to C5; R1 also lowers the voltage applied to the anode of V1 to achieve optimum operating conditions for this stage. The valve heaters are fed via separate leads from the supply plug and individually decoupled by the capacitors C15 to C19.

Power unit Type 886 (fig. 7)

41. AC mains are applied to the primary of the mains transformer TR1 via a double-pole on-off switch SW1 and fuses FS1, FS2.

42. HT is derived from a centre-tapped high-voltage secondary on TR1, in conjunction with a full-wave rectifier V1. The DC output from the rectifier is applied to a capacitance-input filter, consisting of a reservoir capacitor C1, followed by a smoothing choke L1 and smoothing capacitor C2. A discharge resistor R2 is connected across C1.

Voltage stabilizer

43. The smoothed DC voltage across C2 is applied to a series-type voltage regulator, consisting of the valves V3 to V7. The triode-connected tetrode V3 functions as the regulator valve in series with the HT supply from the rectifier; the impedance of

V3 is controlled by a DC amplifier, V4. The cold-cathode voltage stabilizers V5, V6 and V7 are connected in series across the smoothed DC supply, and provide constant anode, screen and cathode voltages for the control valve. The anode of V4 is connected to this stabilized source via R8; the grid is connected to a positive voltage derived from a potential divider consisting of R11, RV1, and R10 in series across the stabilized HT output of the power unit.

44. The stabilizer operates in such a manner that the output voltage between cathode of the regulator valve V3 and earth, is substantially independent of the external load or the input voltage from the HT rectifier.

45. The operation of the circuit is as follows. Any fluctuation in the output voltage, due to increase or decrease of the load, will vary the potential applied to the grid of V4. As the cathode potential of V4 is constant, the effective grid bias applied to V4 will thus change.

46. This change in grid voltage is amplified by V4. The resultant change in anode voltage across R8 is applied to the grid of V3; this produces a change in impedance and hence a change in voltage drop across V3, which opposes the change in output voltage. The output voltage maintained by the regulator is determined by the grid potential of V4, and is thus dependent on the setting of RV1.

47. Similar reasoning applies in respect of variations in the output voltage caused by increase or decrease of the DC input voltage to the stabilizer.

48. The action of the stabilizer is instantaneous and the effect is to provide a constant voltage supply of low internal impedance.

95V negative supply

49. A 95V negative supply is incorporated in the power unit derived from a tap on one half of the HT secondary winding on TR1. The AC voltage between this tap and earth is applied to a half-wave rectifier V2; the DC output voltage of the rectifier is smoothed by a two-section choke input filter consisting of L2, C3 and L3, C4. A discharge resistor R1 is connected across C3.

50. The smoothed DC voltage across C4, negative with respect to earth, is applied through a series resistor R8 to the cold-cathode voltage stabilizer V8. The priming electrode of V8 is connected to the negative pole of the supply through R6. The stabilizer has a constant voltage drop of 95. This supply feeds a preset potentiometer RV2, connected in series with R24. The voltage on the slider of RV2 is applied via SK4 to SK5 on the Amplifier A 3691 and thus to the grid of V1 (para. 34).

Heater supplies

51. The heater supplies for the rectifier valves V1, V2 and the stabilizer valve V3, V4 are derived from low-tension secondary windings on TR1.

52. The heater supplies for the RF amplifying unit and the IF amplifier are obtained from an additional LT winding. This winding delivers 6.5V; the increased voltage is necessary in view of the voltage drop along the interconnecting cables to the two units. A separate LT winding is used to feed the pilot lamp LP1 on the power unit.

Output sockets

53. The output of the power unit is terminated at the sockets SK2, SK3 and SK4.

54. Supplies for the IF amplifier are derived from SK2. The 210V positive HT supply and the 6.3V LT supply are connected to SK2/C and SK2/F respectively. SK2/E is a common earth connection.

55. The RF amplifying unit is connected to SK3. The HT supply is terminated at SK3/A and SK3/D, the supply to SK3/D being taken via SW3 the HT ON/OFF switch (para. 30). The heaters supply is connected to SK3/F.

56. The 95V negative supply is terminated at SK3/C, while the variable bias supply is taken to SK4.

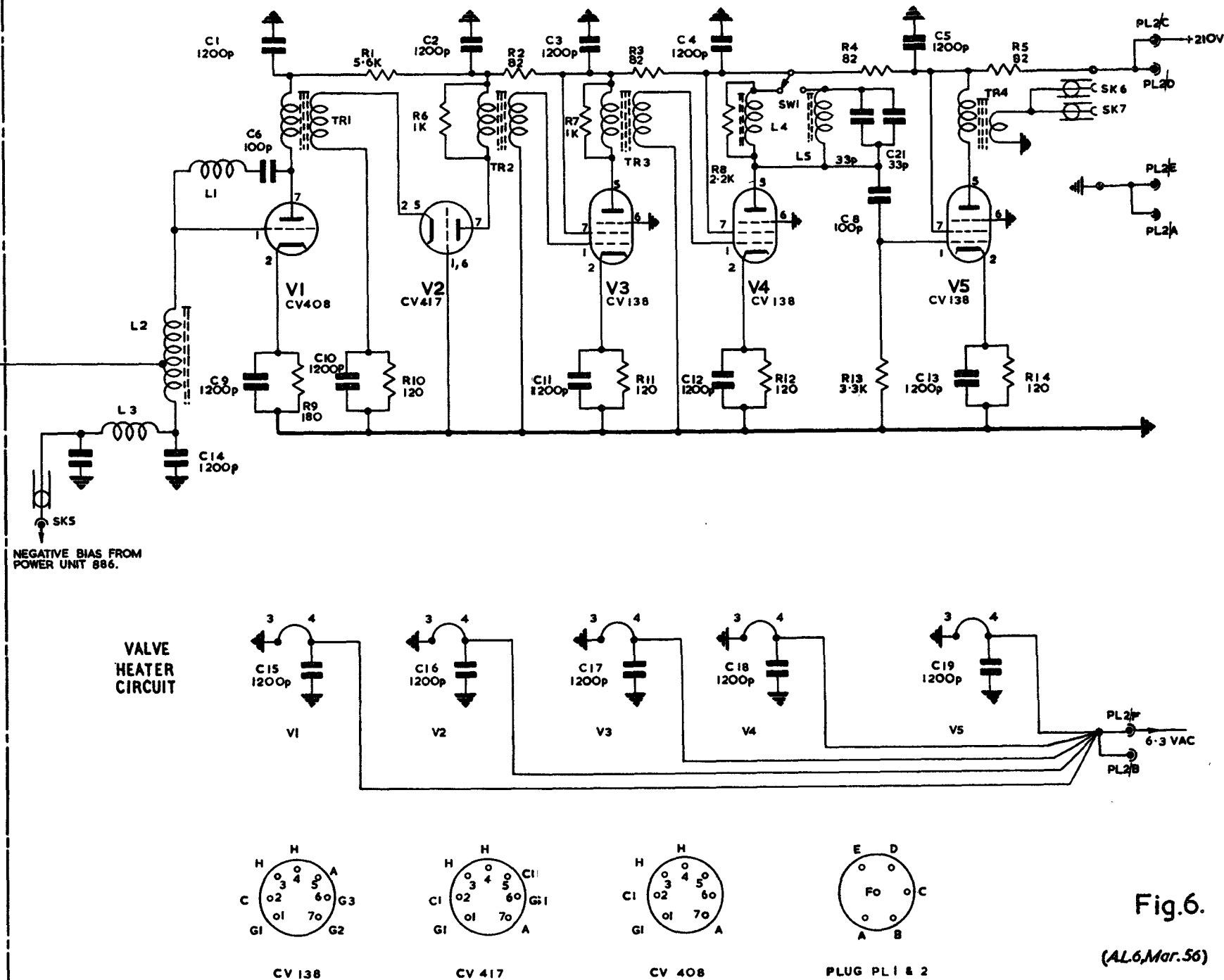
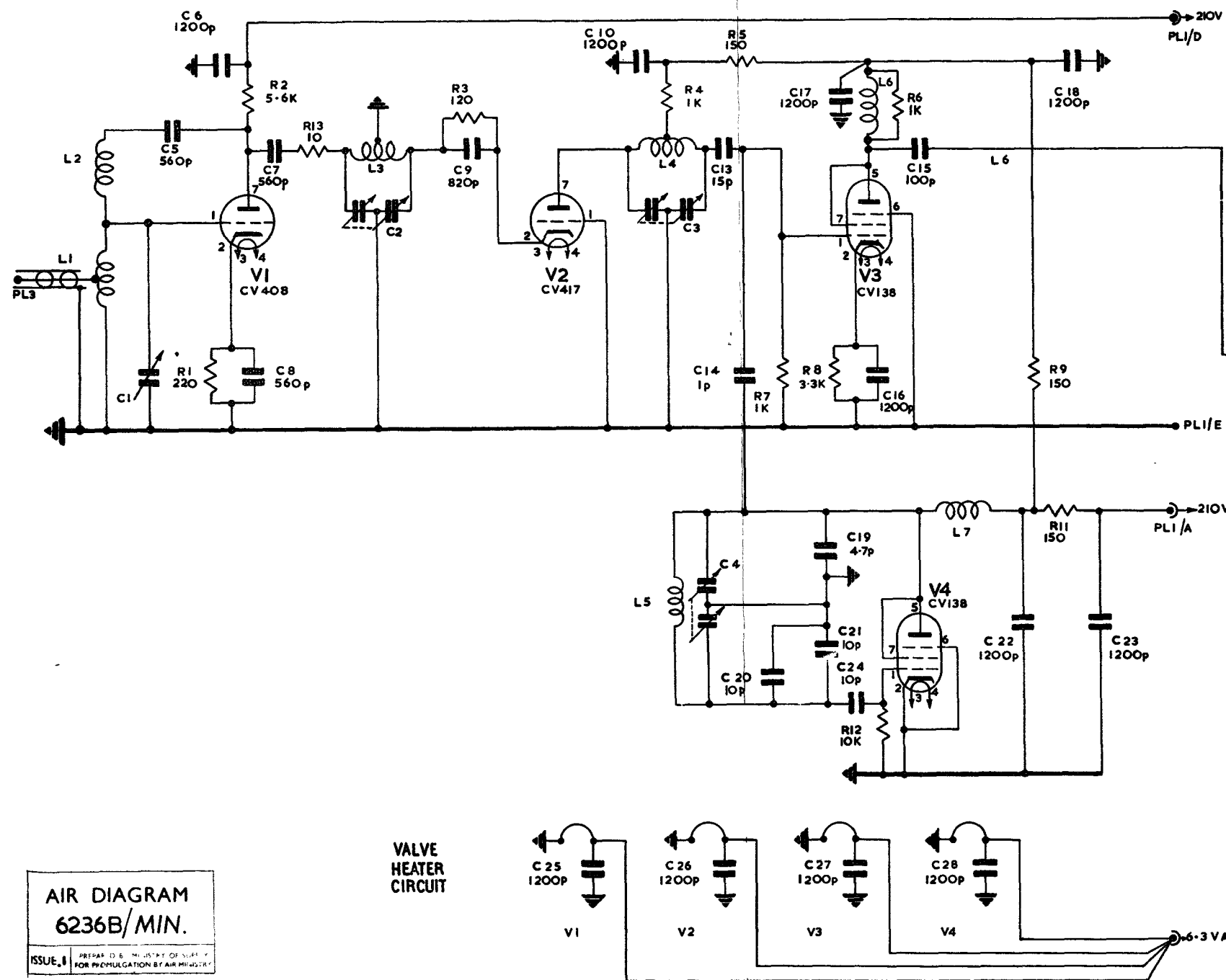
Meter circuit

57. The milliammeter M1 (0.5mA FSD) in series with R19 may be switched in parallel with shunt

resistors to measure the current drawn from the three 210V positive output terminations and the 95V negative supply. The meter is switched to the appropriate circuit by SW2. In each instance it is necessary to apply a multiplying factor to the meter reading to obtain the actual current reading in milliamperes.

58. The meter connections for each of the five switch positions are:—

- (1) 210V HT to SK3/D (HT to V1 on RF amplifying unit). In this position the meter is connected across the shunt resistors R14, R15. Actual current = meter reading $\times$ 20.
- (2) 210V HT to SK2/C (HT to IF amplifier). The meter is connected across the shunt resistor R13 and R20. Actual current = meter reading $\times$ 20.
- (3) 210V HT to SK3/A (HT to RF amplifying unit). The meter is connected across R16 and R17. Actual current = meter reading $\times$ 20.
- (4) 95V negative supply to SK3/C (not used). The meter is connected across R18. Actual current = meter reading $\times$ 10.
- (5) 210V Supply. The meter is connected across the HT supply through multipliers R22 and R23. Voltage reading = meter reading $\times$ 100.



AIR DIAGRAM
6236B/MIN.

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RF and IF units - circuit diagram.

Fig.6.

(AL.6, Mar. 56)

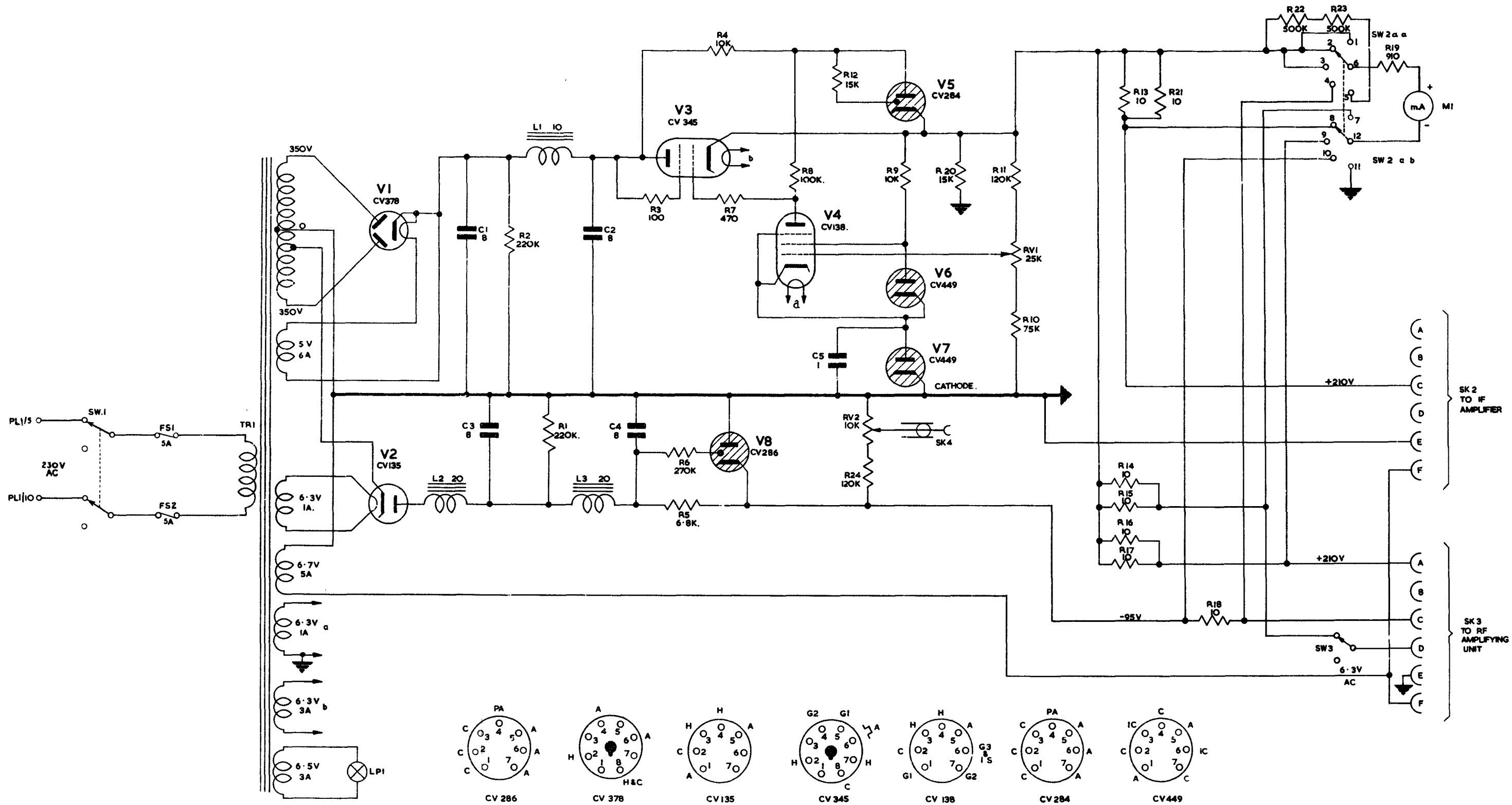


Fig. 7.

Power unit Type 886 - circuit

SECTION 4

AERIAL AND FEEDER SYSTEM

Chapter I

AERIAL ARRAY AND FEEDER SYSTEM

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<i>Radiation in horizontal plane</i>	8	<i>Stationary feeder network</i>	21
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Note.—Fig. 12, 14, 15 and 16 are at the end of the Chapter.

AERIAL ARRAY

Introduction

1. The layout of the aerial system is shown in fig. 14. Three separate aerial arrays are mounted 18 cm. in front of a reflector screen attached to the vertical face of the aerial framework and are arranged as follows:—

(1) *Top array* 32 full-wave centre-fed dipoles, arranged in eight stacks of four dipoles at a mean height of 25 ft.

(2) *Middle array* 16 full-wave centre-fed dipoles arranged in eight stacks of two dipoles at a mean height of 12½ ft.

(3) *Bottom array* similar to middle array but at a mean height of 7½ ft.

In each of the arrays the stacks are divided into four bays, each of two adjacent stacks, cross-connected by a horizontal inter-stack feeder. The centre point of the feeder is connected by $\lambda/4$ lines passing through apertures in the screen to the appropriate main horizontal feeder supplying all four bays of each array.

2. The distance between stacks in all instances is 1.2λ and the vertical spacing between dipoles half a wavelength. Linear feeding of the array is employed.

Mechanical construction

3. The primary radiating elements consists of full-wave dipoles in stacks, each stack being fed from a section of 250-ohm transmission line which

forms the stack feeder. Each half-dipole is approximately $\lambda/2$ long, and is constructed of $\frac{3}{8}$ in. dia. copper tube, suitably shaped and brazed to the appropriate side of the stack feeder, which lies parallel to the screen. The half-dipoles are mounted a distance of approximately 18 cm. in front of the screen by hardwood stand-off pillars, being attached to the half-dipoles at their centres, where a voltage node occurs. The outer ends of the tubes are plugged and rounded to minimize corona losses.

4. The stack feeders are made from $\frac{3}{8}$ in. diameter copper tube spaced $1\frac{1}{2}$ in. apart and are supported at the stub end by a bracket from the screen. The feed points to the half-dipoles are spaced a distance of $\lambda/2$ apart; connections to the half-dipoles on one side of the feeder are made alternately to one feeder tube then the other, so that all elements in a stack are fed in phase.

5. The inter-stack feeders are connected to tapping points near to one end of the stack feeder, the actual connections being by clips which permit adjustment of the tapping point during impedance matching, after which they can be soldered in the correct position. This end of the feeder also has a movable shorting bar fitted across it as a stub-adjustment. These adjustments are made during setting up so that the inter-stack feeders are connected to the stack feeder at a point which presents an impedance of 320 ohms to the inter-stack feeder. This results in the impedance which

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each bay presents at the centre of the inter-stack feeder being 160 ohms.

6. The inter-stack feeders and supporting stubs are shown in fig. 1 and 2. They are made of 300 lb. copper wire ($\frac{1}{8}$ in. o.d.) spaced on 1 in. centres with ring insulators and are connected to the front of 2 : 1 ratio transformers formed by a parallel plate transmission line of 224 ohms impedance and $\lambda/4$ long. These transformers are supported by brackets attached to the screen and are connected at their rear ends to the main horizontal feeders (fig. 3). Their action is to match the 160-ohm impedance at the centre of the inter-stack feeders to the 320-ohm line horizontal feeder.

7. The distance between feed points to the inner and outer bays on the main horizontal feeders is $5\lambda/2$. The RF voltages at the feed points are therefore in anti-phase, and to restore an in-phase condition at the middle of the bays, the connections of inter-stack feeders to vertical stack feeders

on the end bays are transposed with respect to the middle bays. On the inner bays the top conductor of the inter-stack feeder is connected to the front conductor of the vertical stack feeders; on the outer bays the connections are reversed.

Radiation in horizontal plane

8. The measured horizontal radiation diagrams for the three different arrays are shown in fig. 5 to 7.

9. In the vertical plane the aerial system consists of four separate arrays:—

(1) *Top array.* A 4-dipole stack at a mean height of 25 ft.

(2) *Middle array.* A 2-dipole stack at a mean height of $12\frac{1}{2}$ ft.

(3) *Middle + Bottom array.* A 4-dipole stack at a mean height of 10 ft.

(4) *Bottom array.* A 2-dipole stack at a mean height of $7\frac{1}{2}$ ft.

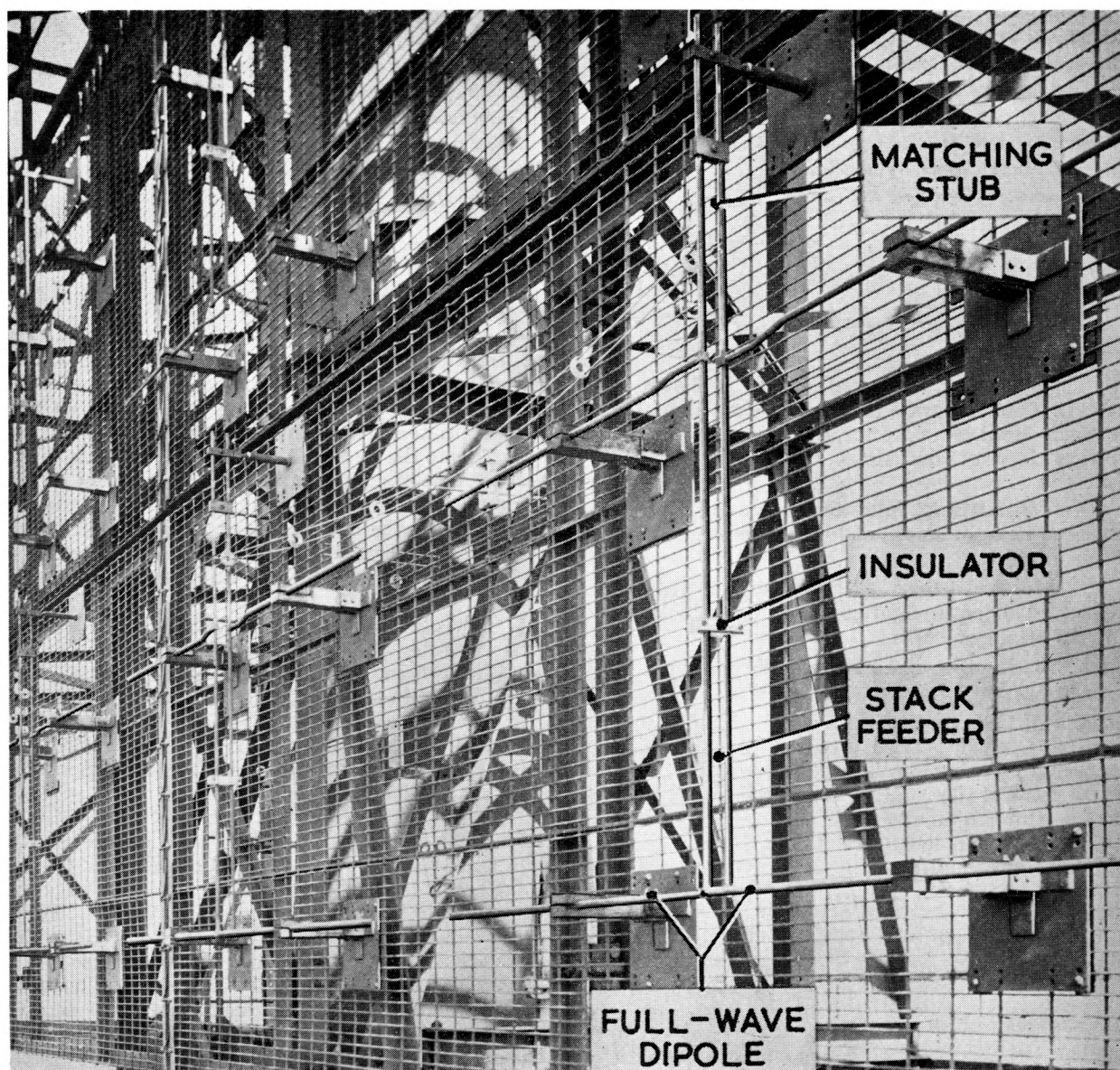


Fig. 1. Aerial bay—general view

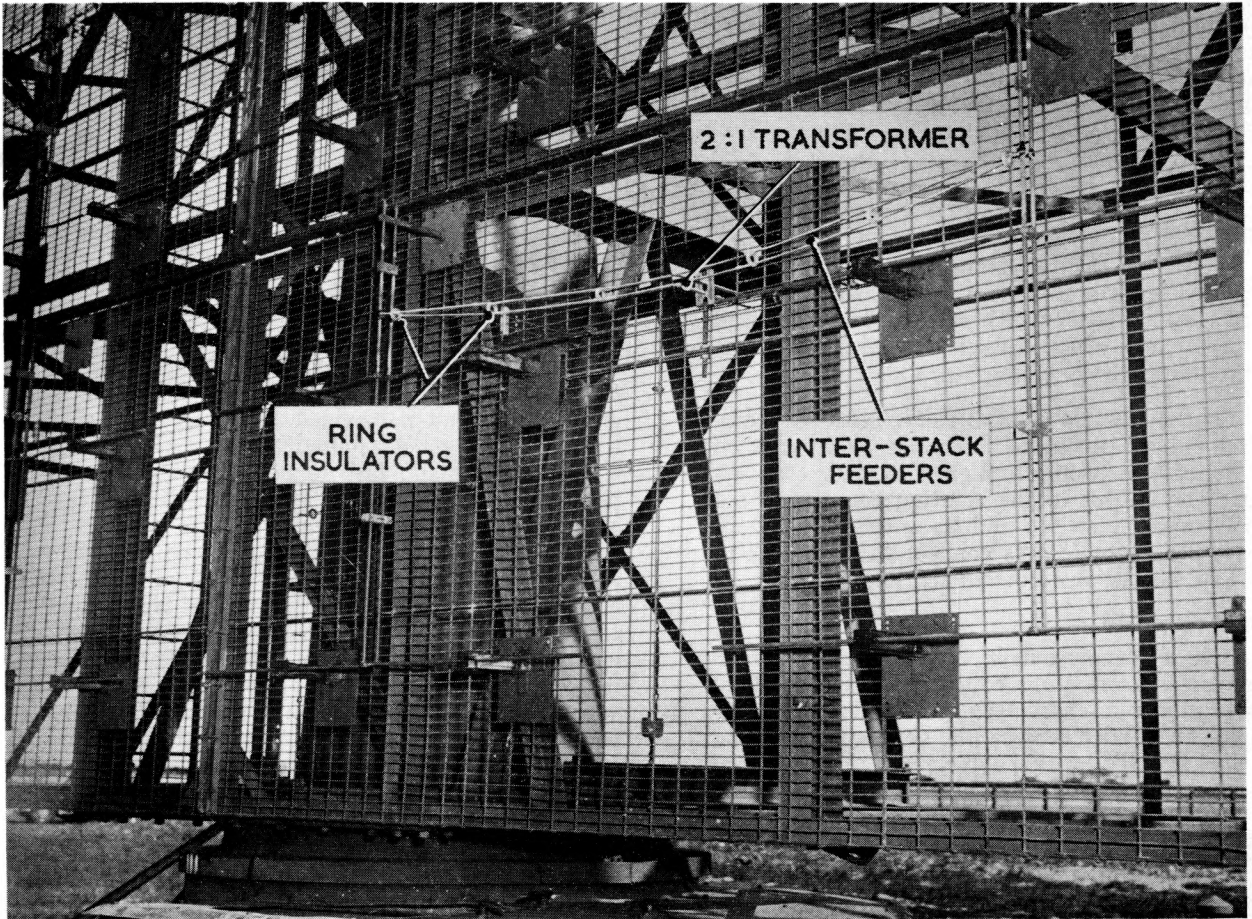


Fig. 2. Inter-stack feeders

10. The vertical radiation diagrams for the various arrays differ due to both the number of dipoles and their mean height above ground. Cartesian radiation diagrams for the two 4-element stack arrays are given in fig. 8 and for the 2-element stack arrays in fig. 9.

11. Height measurement is made by comparing the signal strengths received when operating on two selected aerials; the ratio enables the height of the target to be determined with reasonable accuracy.

12. The four arrays are fed in turn by the capacity switch, transmission being synchronized with switch rotation so that successive pulses are fed to separate arrays, each pulse being transmitted from and received by the same array. The received signals are all fed to the display consoles where the signals from selected aerials only are displayed.

Height measurement

13. Height measurement is performed by comparison of received signals from the various arrays as follows:—

- (1) *High cover*; Middle array with bottom array.
- (2) *Low cover*; Top array with middle + bottom arrays.

(3) *Left phase check*; Middle + bottom array with bottom array.

(4) *Right phase check*; Middle + bottom array with middle array.

14. Height curves for arrays at mean heights of 25 ft. and 10 ft. (*low system*) and $12\frac{1}{2}$ ft. and $7\frac{1}{2}$ ft. (*high system*) are shown in fig. 10. This chart shows the angle of elevation plotted against the ratio of signal strength in the two arrays of each system. It will be seen that, with the *high system*, at small angles of elevation the change in ratio with angle is very gradual, and that high accuracy in height-finding cannot be expected. On the *low system*, however, the slope of the curve is much greater and accurate readings can be obtained at much lower angles. The change in ratio with angle of elevation is also very gradual when the ratio on the normal curve approaches 10 : 0 or 0 : 10, that is, when the signal from either aerial approaches zero. At these angles of sight the ratios are obtained from comparison of the signals from the arrays at 10 ft. and $7\frac{1}{2}$ ft. (left phase check) or the arrays at 10 ft. and $12\frac{1}{2}$ ft. (right phase check), the left phase check being used when the height ratios on the *high system* approach 0 : 10 and the right phase check when they approach 10 : 0. The height curves for these cases are shown in fig. 11.

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15. A theoretical height chart based on fig. 10 and 11 is given in fig. 12, from which the theoretical height of a target may be calculated after the range and signal-strength ratio have been determined. The chart is used by placing a straight-edge to cut the point of origin of the range and height scales and the ratio given on the applicable system

scale. The height is then read off against the point of intersection of the straight-edge and the range ordinate. Extension of the straight-edge gives the angle of elevation on the top scale of the chart. A chart similar to this is prepared when the equipment is calibrated.

FEEDER SYSTEM

Introduction

16. Either of the two transmitters Type T.3705 in the transmitter well may be connected to the main vertical feeder which runs up from the well to the capacity switch cubicle via the inside of the central supporting column.

17. The stationary vertical feeder in the capacity switch cubicle is coupled to the feeder network on the aerial framework through a rotating coupling unit. The output of the rotating coupling is fed to the capacity switch and its switching network (*Chap. 3*); three feeders connect this network to the Top, Middle and Bottom arrays.

General description

18. The feeder system in the transmitter well is constructed from $\frac{1}{4}$ in. copper tube spaced 2 in. apart, giving a characteristic impedance of 320 ohms. The feeder runs up the supporting column, in the capacity switch cubicle and in the aerial

framework are constructed of 300 lb. copper wire spaced at 1 in. centres. The junctions between the 2 in. and 1 in. spacing are made by constant impedance taper transitions in which the outside diameter of the conductors is reduced from $\frac{1}{4}$ in. to $\frac{1}{8}$ in., while the spacing between them is reduced from 2 in. to 1 in. Wherever possible, the feeders are kept taut and maintained at the correct spacing by tensioning screws bolted to the aerial framework; in the 2 in. feeders the tensioning screws pass through a central clearance hole in a brass spacing block to which the ends of the feeders are brazed, while on the 1 in. feeders the wires are attached to feeder straining brackets, one direct and one via a turnbuckle. The bracket is attached to the aerial frame by a tensioning screw. This enables both wires to be kept taut. Where tensioning of the 2 in. feeder is not possible, polystyrene spacers are fitted to maintain the spacing between feeder lines. These spacers are attached to the lines by beryllium copper clips and are so shaped that

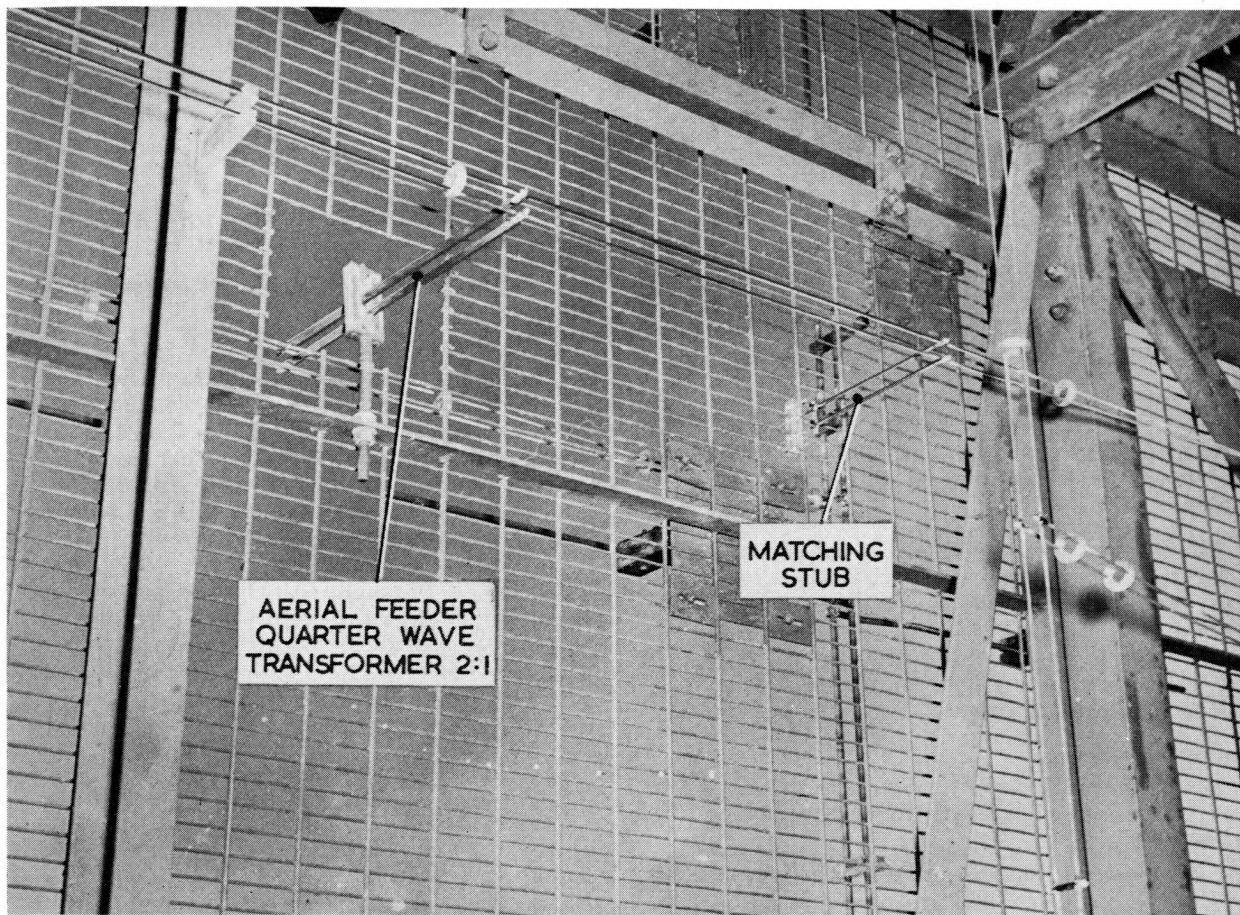


Fig. 3. Aerial feeder—quarter wave transformer

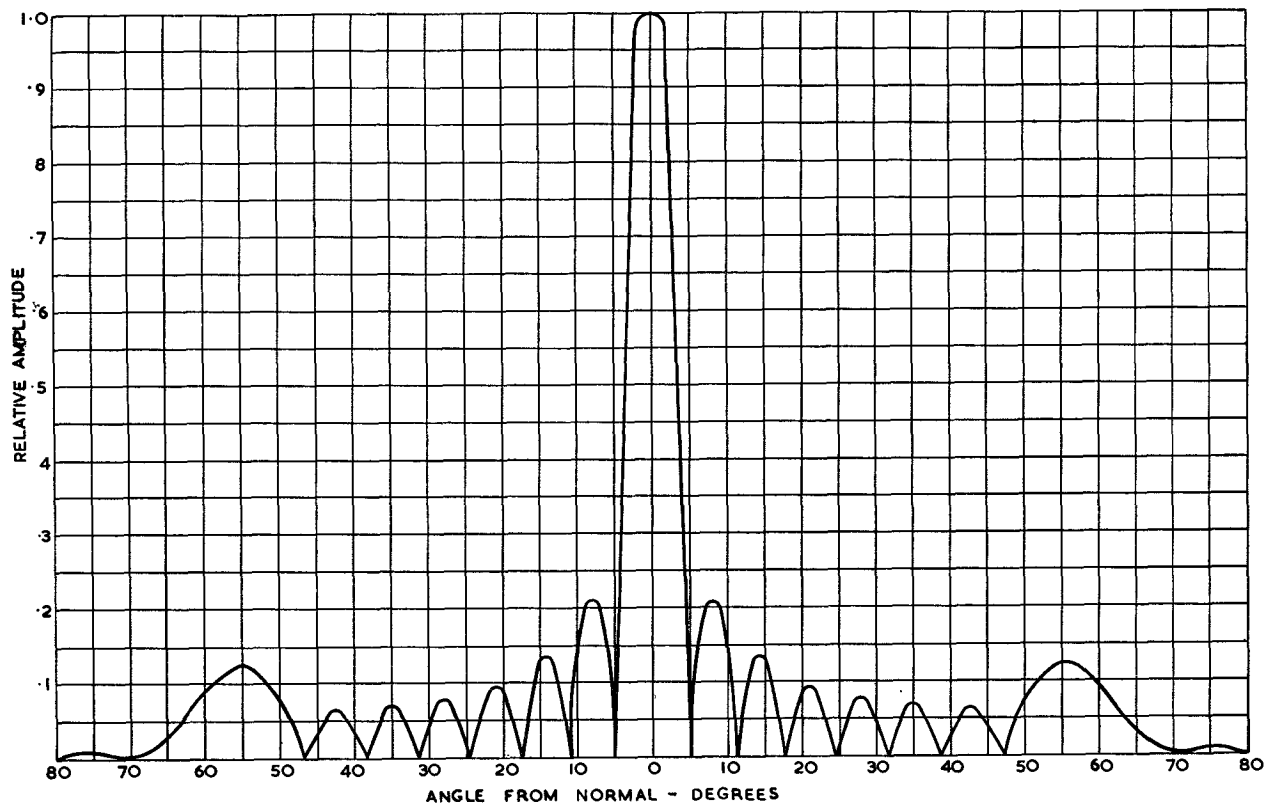


Fig. 4. Theoretical horizontal radiation diagram

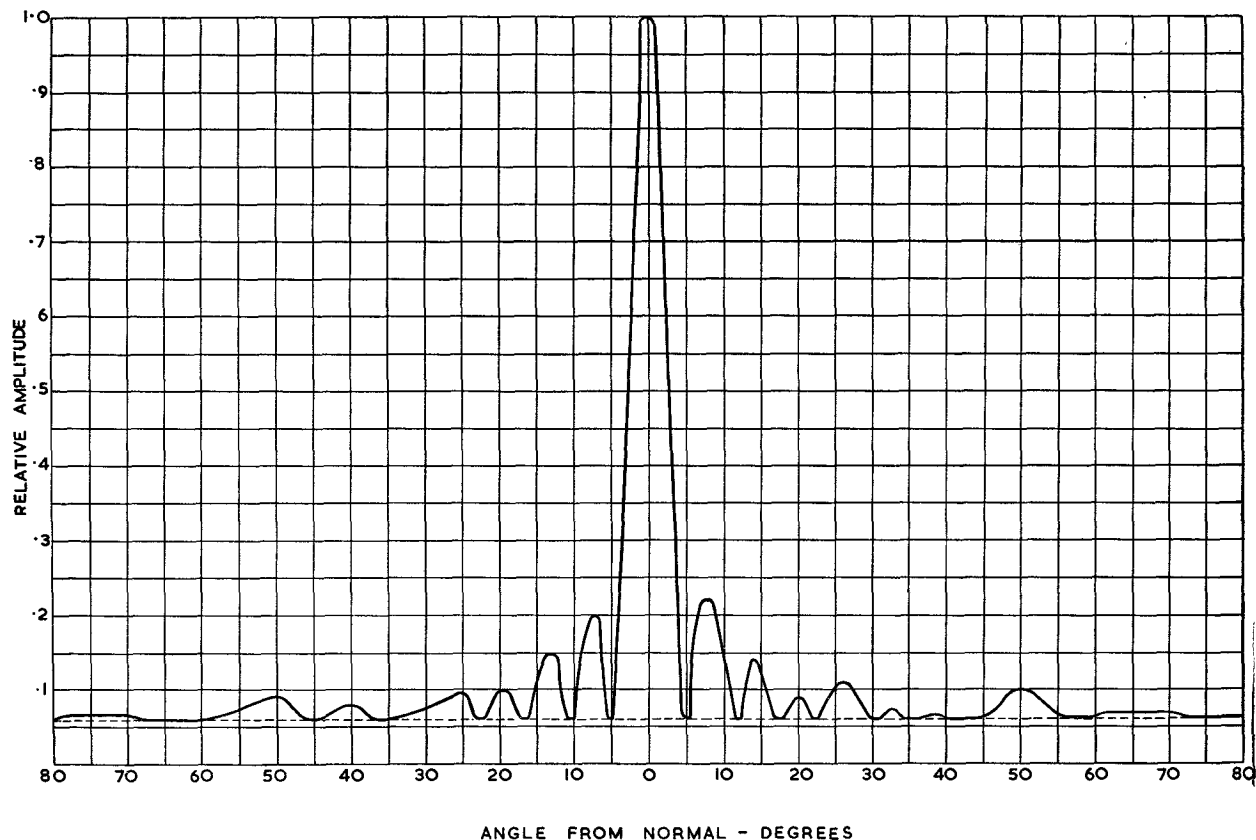
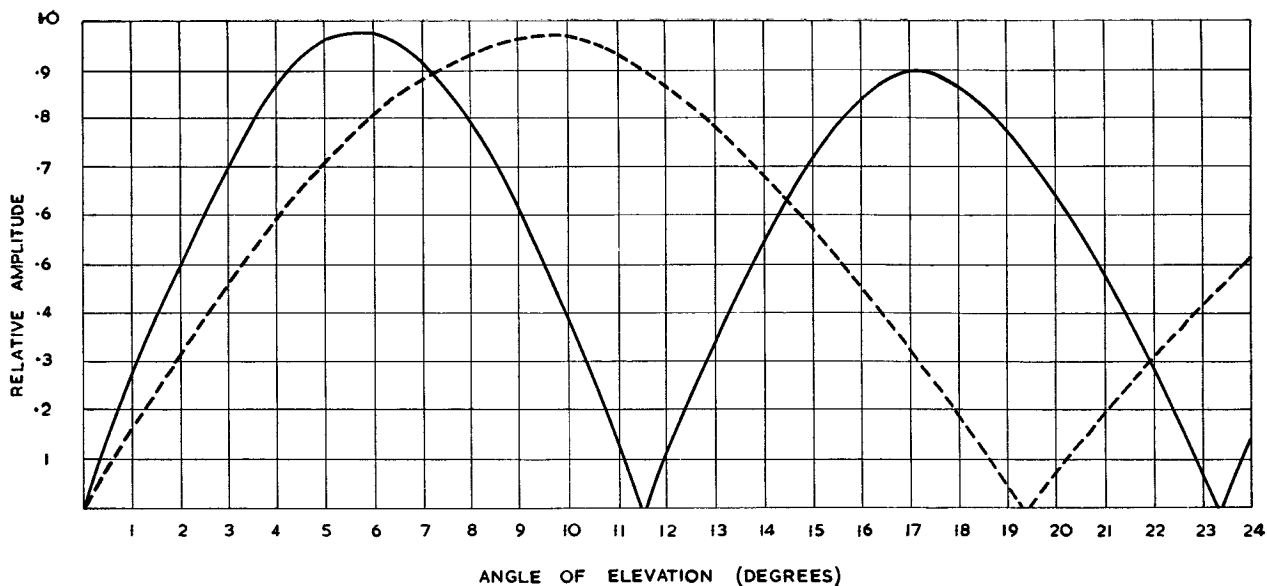


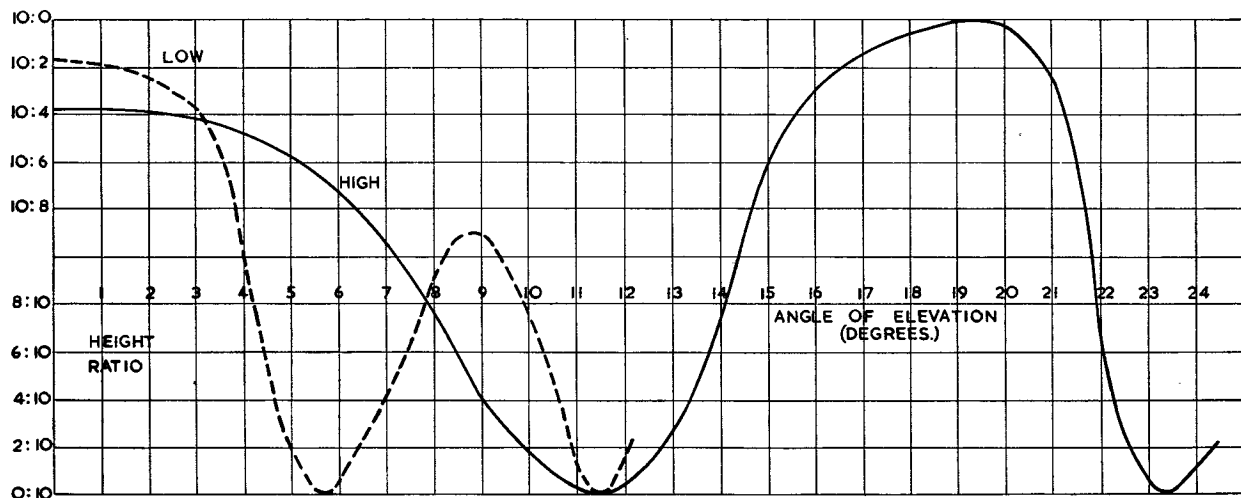
Fig. 5. Measured horizontal radiation diagram—top array

(A.L.9, July 56)



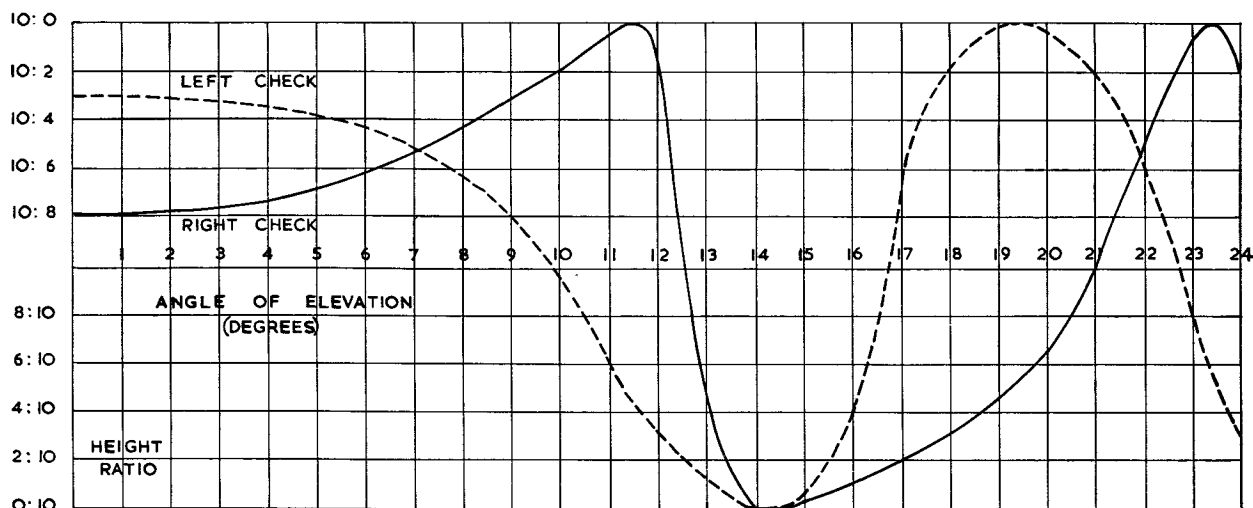
— MIDDLE ARRAY
 --- BOTTOM ARRAY.

Fig. 9. Vertical radiation diagram—2 stack arrays



— MIDDLE ARRAY AND BOTTOM ARRAY. (HIGH SYSTEM.)
 --- TOP ARRAY AND MIDDLE + BOTTOM ARRAY (LOW SYSTEM.)

Fig. 10. Theoretical height curves—high and low systems



—— MIDDLE + BOTTOM ARRAYS AND MIDDLE ARRAY (RIGHT CHECK)
 - - - - MIDDLE + BOTTOM ARRAYS AND BOTTOM ARRAY (LEFT CHECK)

Fig. 11. Theoretical height curves—right and left checks

coupling unit are attached to, and rotate with the aerial framework.

Coupling unit

24. As the original design of the coupling unit did not prove satisfactory with the redesigned feeder system (it was found impossible to obtain sufficiently tight coupling) a different design using capacitive is now fitted. The design is basically a capacitor placed in series with each feeder line and so arranged that one plate of each capacitor can be rotated. The reactance introduced into the feeder is easily tuned out, and in addition, the electrical stresses are much less than those with inductive coupling. The unit can be seen in fig. 17. It comprises two rotatable brass rings 7 in. in outside diameter, 4 in. in inside diameter and $\frac{3}{16}$ in. thick, and two 120 deg. sectors of similar rings, all arranged concentrically. The sectors form the fixed plates and are mounted on two polystyrene pillars on a base attached to the top of the slip-ring pedestal, which remains stationary. The rings are fixed to a polystyrene spider which is free to turn about a vertical spindle attached to the centre of the base; this spider rotates with the cubicle and the rings thus rotate between and parallel to the fixed plates. The spacing between corresponding fixed and moving plates is $\frac{1}{16}$ in. giving a capacitance between the plates of approximately 35 pF. The output feeder is connected to the rotating plates by $\frac{1}{4}$ in. diameter copper tubes which lead from the inner faces and upwards through the inside of the rings. The input feeder is connected to blocks on the outer faces of the

fixed plates. The equivalent capacitance is corrected by an inductive stub across the feeder at the point of connection with the fixed plates. The output of the coupling unit (2 in. spacing) is fed to the capacity switch feeder network (1 in. spacing) via another constant impedance transition.

Capacity switch

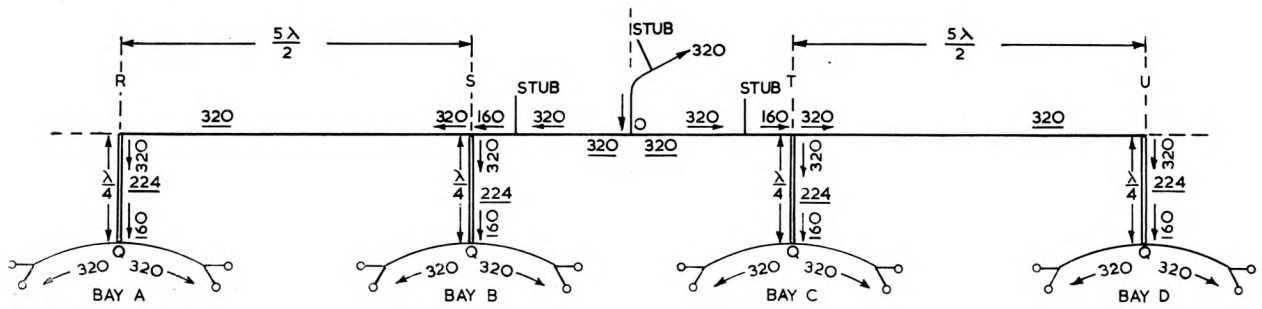
25. Full information on the principles of operation of the capacity switch, its associated feeder network and construction will be found in Chap. 3. Briefly, its function is to switch the transmitter output alternately to the Top, Middle, Middle+Bottom and Bottom arrays. It does this by cyclically changing the capacitance across the ends of four feeders, and using the change in the feeder input impedance so produced to carry out the switching. Three output feeders are taken from the capacity switch feeder network, one feeder to each of the Top, Middle and Bottom arrays.

Rotating feeder system

26. Details of the feeder runs in the capacity switch cubicle are shown in Chap. 3, fig. 6. Three horizontal output feeders are taken from the capacity switch feeder network, one to each of the Top, Middle and Bottom arrays. The horizontal feeders are led out of the cubicle through perspex windows.

27. The main vertical feeder leading to the Top array is directly connected to the appropriate horizontal feeder from the cubicle (fig. 15), carrying on as a stub support. For feeding the Middle and

(A.L.9, July 56)



FEEDER IMPEDANCES SHOWN THUS $\underline{224}$.

$\underline{320}$ INDICATES IMPEDANCE OF FEEDER IN THE DIRECTION INDICATED.

Fig. 13. Feeder matching diagram

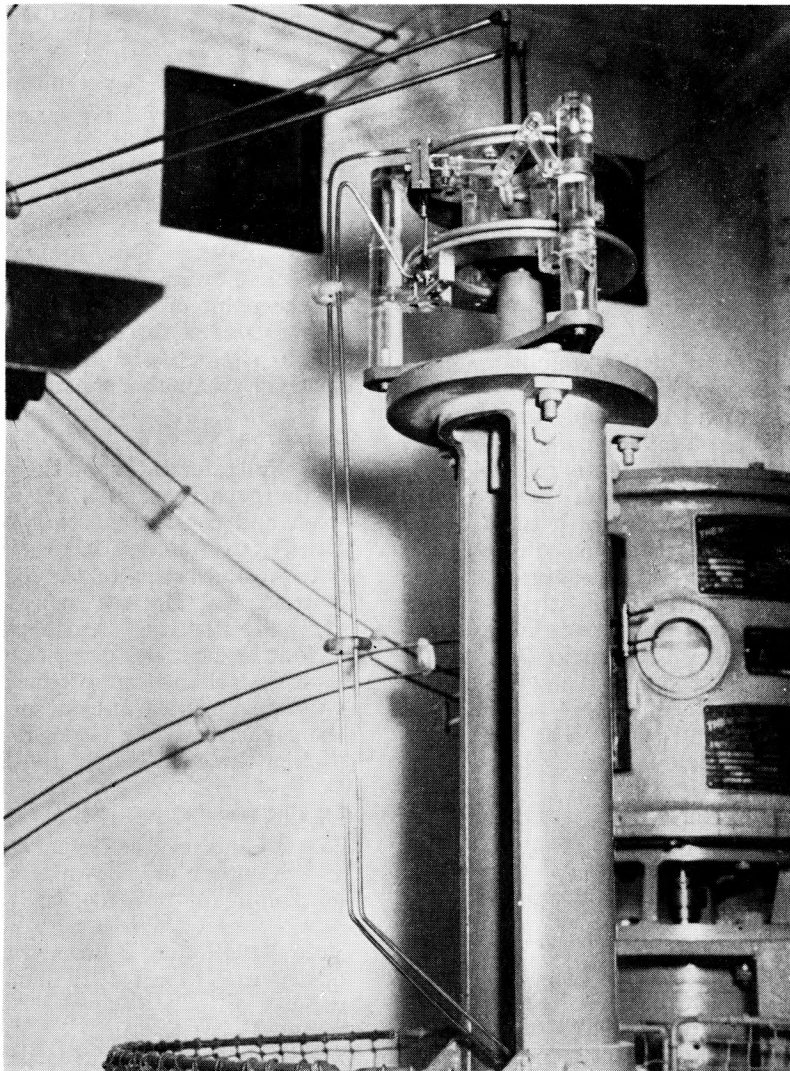


Fig. 17. Interior of capacity switch cubicle

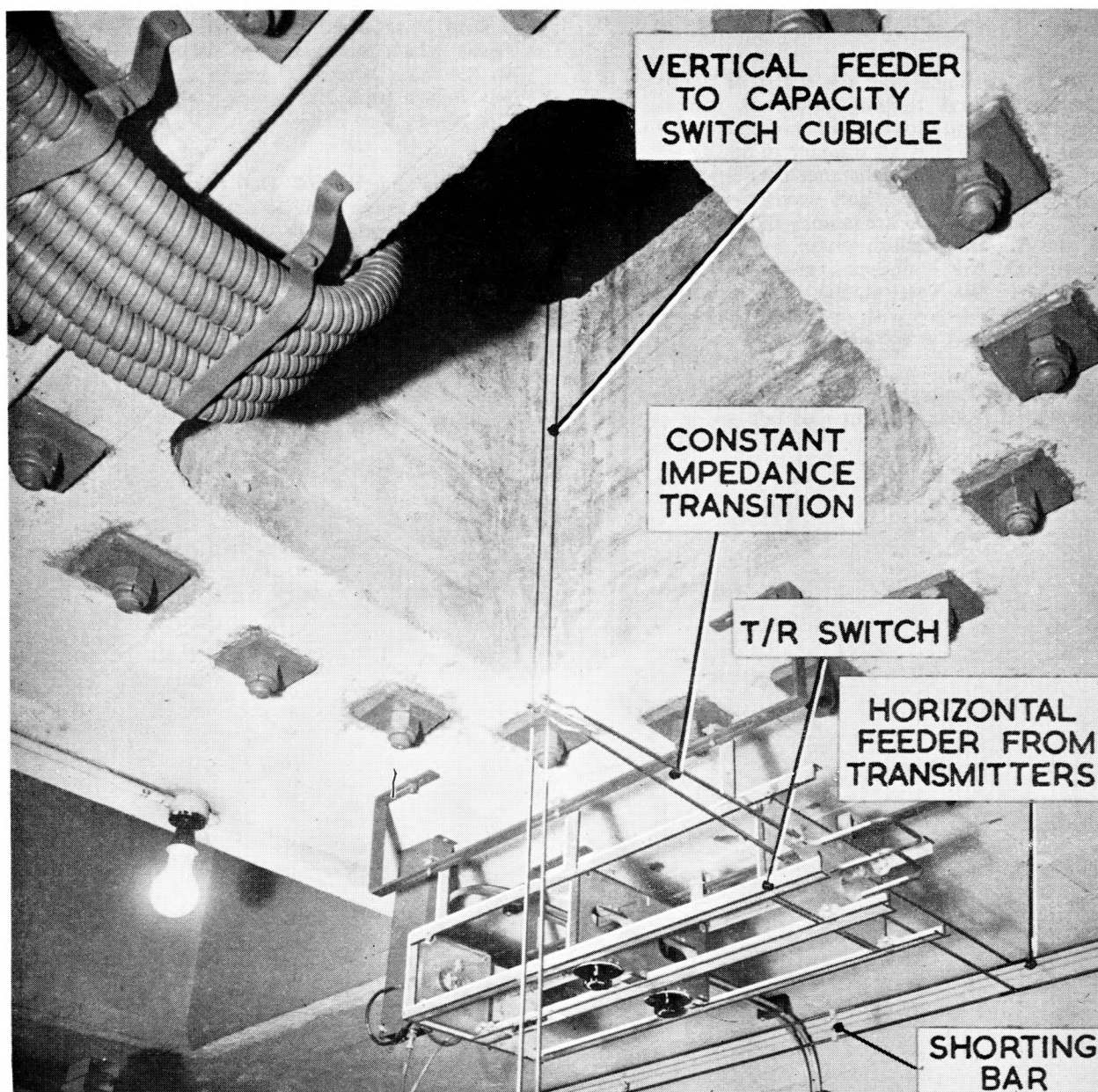


Fig. 18. Junction of vertical and well feeders

Bottom arrays, the two horizontal feeders leading to the Middle and Bottom arrays are extended outside the cubicle and are fixed under tension to the aerial frame. Short lengths of untensioned feeder then connect the horizontal feeders to the main vertical feeders. At appropriate heights on the three main vertical feeders interconnecting feeders are tapped off which lead to the centre point of the main horizontal feeders connected to the arrays. These short interconnecting feeders are each supported by stub supports, formed by a length of vertical feeder short-circuited a quarter-wavelength above and below the points where it joins the actual feeder.

28. The main horizontal feeders, one for each aerial, are each some 40 ft. in length, and are

tensioned at suitable heights behind the reflecting screen. Connection from these feeders to the centre points of each of the four inter-stack feeders on each array is made by a quarter-wavelength transformer passing through openings cut in the reflector screen. The ends of the horizontal feeder outside the outer junctions are isolated by shorting bars a quarter-wavelength away from the tapping points. The transformers to the inter-stack feeders consist of two parallel plates which form a quarter-wave transformer having an impedance of 224 ohms, giving an impedance ratio of 2 to 1. Adjacent to the points of connection of the inner bays with the horizontal feeder stubs are attached to the feeder. These are necessitated to match the impedance of 160 ohms, obtained by connecting the feeder runs to the outer bays in parallel with

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the 320 ohms input to the transformer feeding the inner bays, to the remainder of the horizontal feeder.

29. The distance from the centre of the array of the aerial feed tapping points is indicated in fig. 13. Accurate location of these points is important to ensure that all primary radiating elements are fed in phase. The distance between the middle and end bays is five half wavelengths, thus the voltages at **R** and **U** are in anti-phase with those at **S** and **T**. To establish phase equality at all the points **O**, the connection from the inter-stack feeders to the vertical stack feeders at bays **A** and **D** are reversed with respect to the corresponding connections at bays **B** and **C**.

30. At the centre point **O** the two halves of the horizontal feeder to right and left are in parallel

across the main feeder giving an impedance value of 160 ohms. To transform this value to 320 ohms, a stub is attached to the short-inter-connecting feeder which joins the appropriate vertical feeder to the main horizontal feeder at a distance of a few inches from the centre point of the feeder; this can be seen in fig. 15.

31. The lengths of the feeders between the capacity switch cubicle and the centre of the horizontal feeders are fixed and should not be altered; they are so chosen that the total feeder lengths from transmitter to centre of horizontals differ by multiples of a wavelength. If the aerial taps along the horizontal feeders are correctly located the radiation from all arrays will be in phase; this is necessary to ensure that, when the Middle and Bottom arrays are used together, the two arrays radiate in phase.

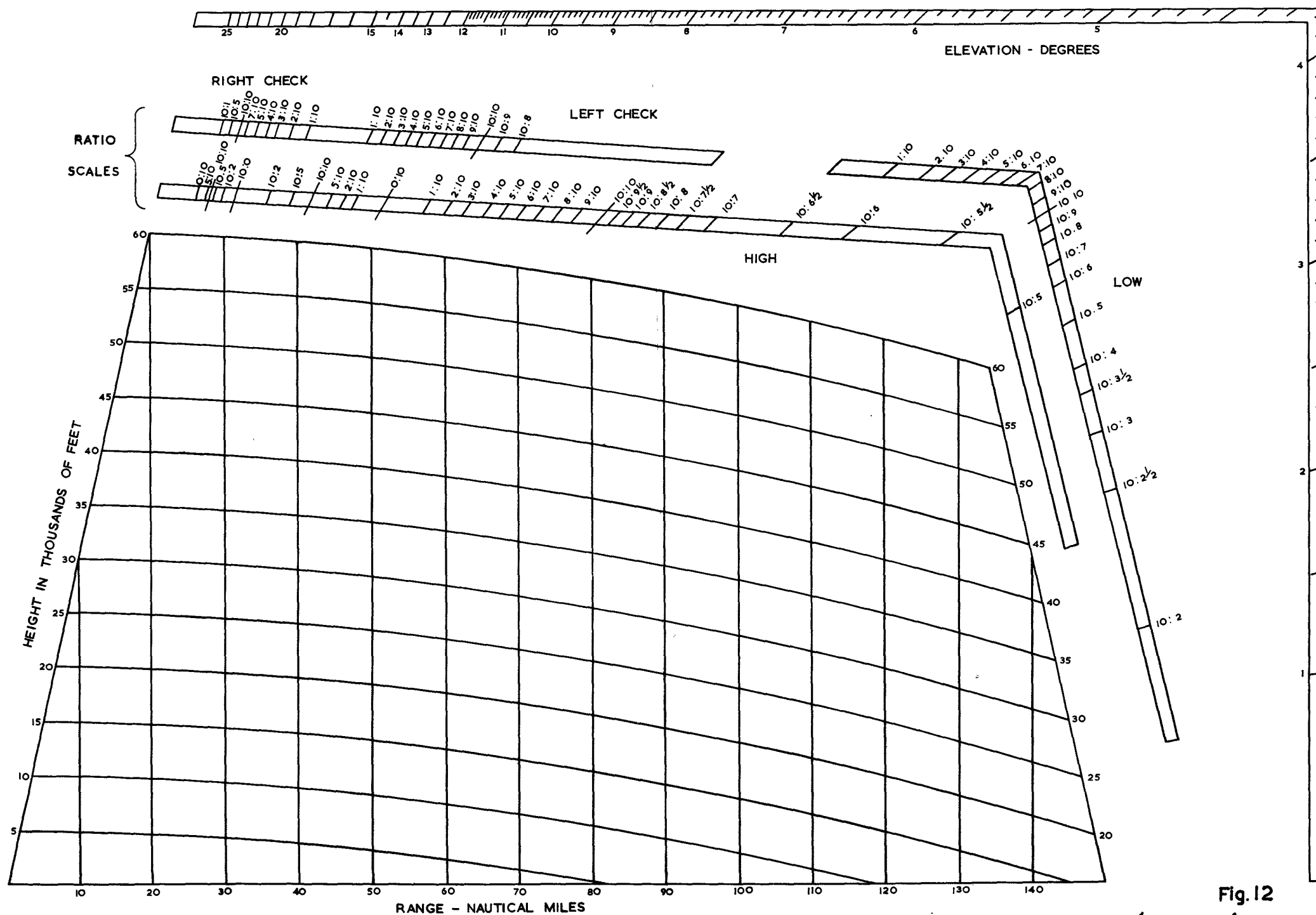


Fig. 12

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Theoretical height chart.

Fig. 12
(AL 9 Jul. '56)

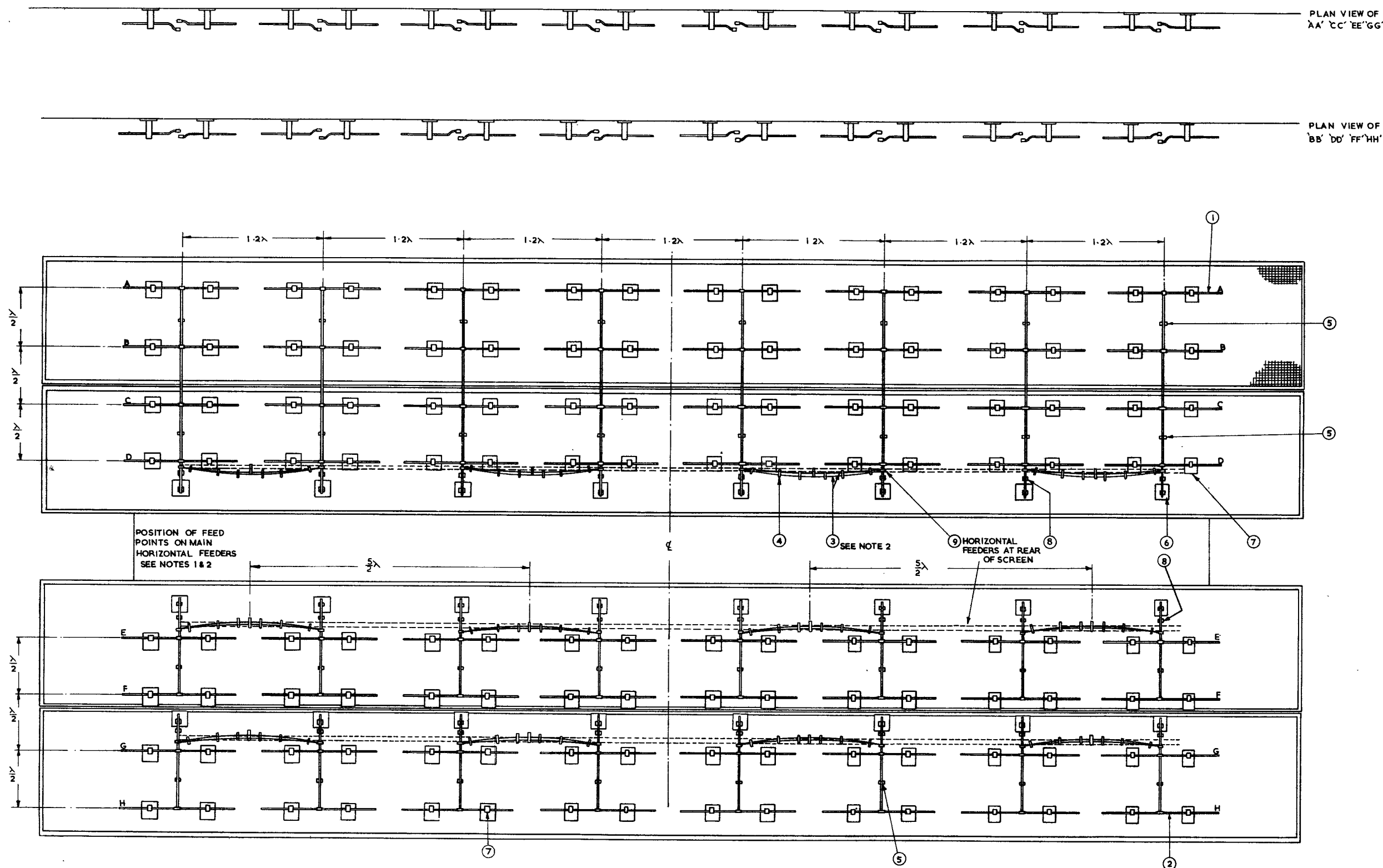
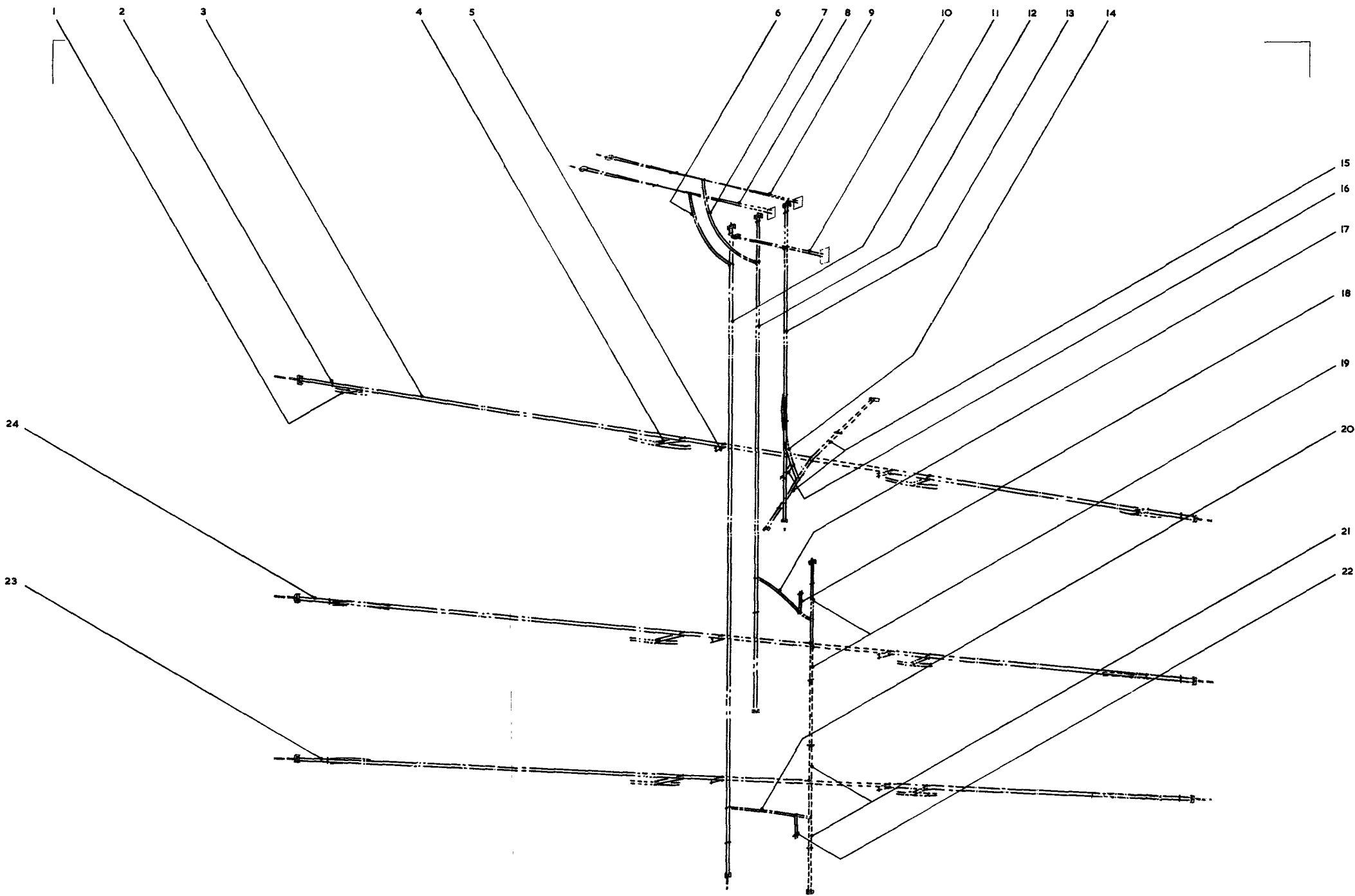


Fig. 14



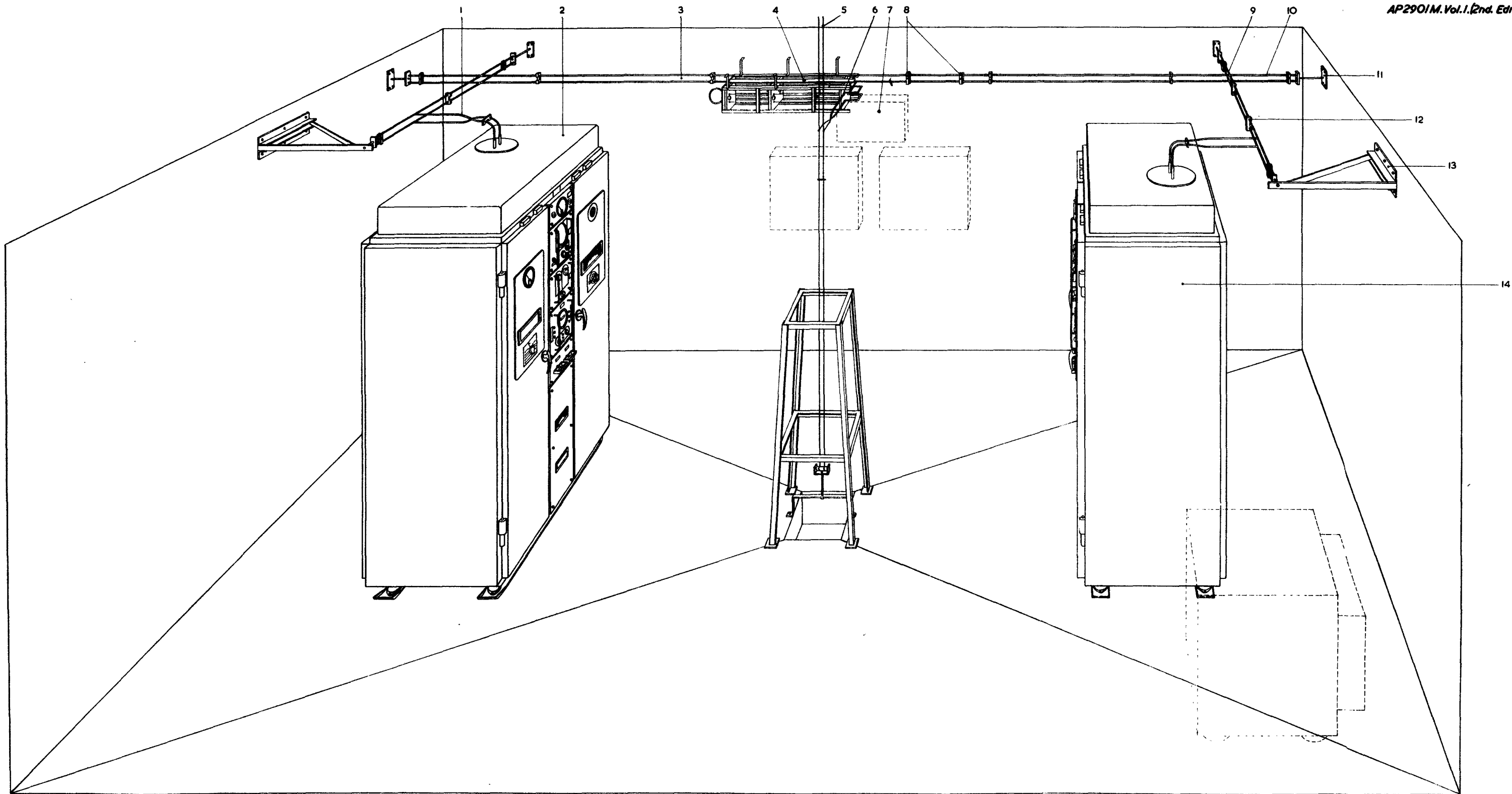
- KEY.
- 1. INTERSTACK FEEDER
 - 2. SHORTING BAR
 - 3. MAIN HORIZONTAL FEEDER (TOP ARRAY)
 - 4. QUARTER WAVE TRANSFORMER
 - 5. MATCHING STUB
 - 6. INTER-CONNECTING FEEDER
 - 7. INTER-CONNECTING FEEDER
 - 8. HORIZONTAL FEEDER FROM CAP. SW. CUBICLE (BOTTOM ARRAY)
 - 9. HORIZONTAL FEEDER FROM CAP. SW. CUBICLE (MIDDLE ARRAY)
 - 10. HORIZONTAL FEEDER FROM CAP. SW. CUBICLE (TOP ARRAY)
 - 11. MAIN VERTICAL FEEDER (BOTTOM ARRAY)
 - 12. MAIN VERTICAL FEEDER (MIDDLE ARRAY)
 - 13. MAIN VERTICAL FEEDER (TOP ARRAY)
 - 14. INTER-CONNECTING FEEDER
 - 15. SUPPORTING STUB
 - 16. MATCHING STUB
 - 17. INTER-CONNECTING FEEDER
 - 18. MATCHING STUB
 - 19. SUPPORTING STUB
 - 20. INTER-CONNECTING FEEDER
 - 21. SUPPORTING STUB
 - 22. MATCHING STUB
 - 23. MAIN HORIZONTAL FEEDER (BOTTOM ARRAY)
 - 24. MAIN HORIZONTAL FEEDER (MIDDLE ARRAY)

Fig.15.

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Feeder Runs in Aerial Frame

Fig.15.
(AL9 Jul '56)



KEY.

- 1 TRANSMITTER OUTPUT.
- 2 TRANSMITTER No. 1.
- 3 TRANSVERSE FEEDER.
- 4 SWITCH UNIT TYPE 405.
- 5 VERTICAL FEEDER TO CAPACITY SWITCH CUBICLE. 1'.
- 6 CONSTANT IMPEDANCE TAPER 2" TO 1'.
- 7 SIGNAL GENERATOR (NOISE)
- 8 MOVABLE SHORTING STUB.
- 9 SUPPORTING STUB.
- 10 SUPPORTING STUB.
- 11 FEEDER STRAINER
- 12 SPACER
- 13 FEEDER SUPPORTING BRACKET.
- 14 TRANSMITTER No.2.

Fig. 16

(AL 9 Jul '56)

Fig. 16.

Feeder Runs In Transmitter Well

Chapter 2

SWITCH UNIT (T AND R) TYPE 405

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Open spark gaps	3		

Introduction

1. Radar Type 7, Mk. 2 and 3 use a common aerial and feeder system for both transmission and reception. Aerial switching is performed by switch unit (T and R) Type 405, which ensures that :—

- (1) During transmission, the transmitter power is fed to the aerial without loss, and the receiver is isolated.
- (2) During reception, received signal voltage is fed without loss to the receiver, and the transmitter is isolated.

2. The switch unit is of the spark-gap type, and makes use of the properties of open- and short-circuited resonant lines to obtain the correct conditions.

Principles of operation

3. A functional diagram of the switch unit is shown in Fig. 1. It consists essentially of two $\lambda/2$ lines ABC and DEF, connected across the balanced feeder at points A and D, which are $\lambda/4$ apart. The line ABC is connected to the receiver at C ; a spark-gap is connected across the line at B, so that AB and BC are each $\lambda/4$ long.

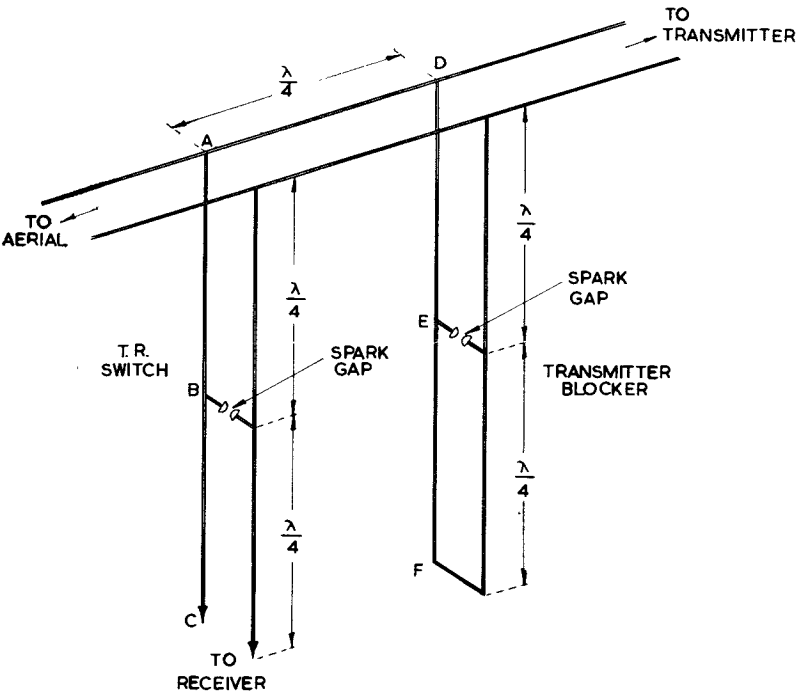


Fig. 1. Functional diagram

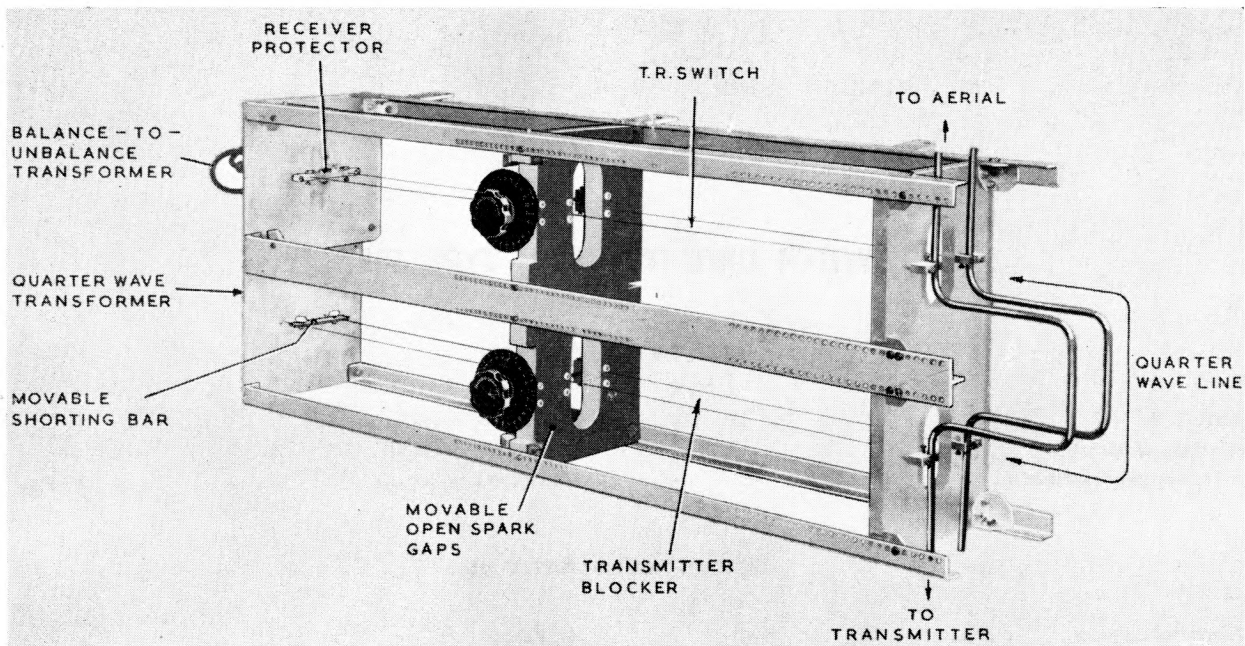


Fig. 2. Switch unit (T & R) Type 405, general view

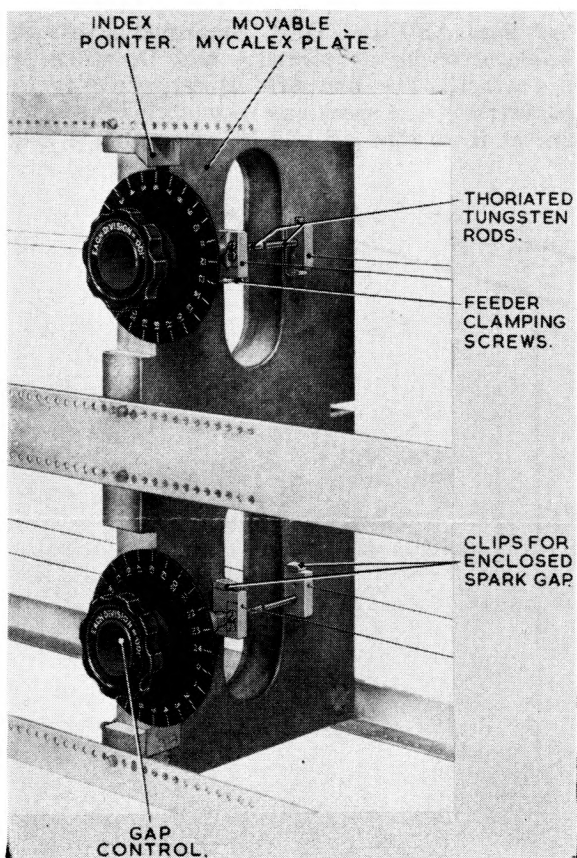


Fig. 3. Open spark gaps

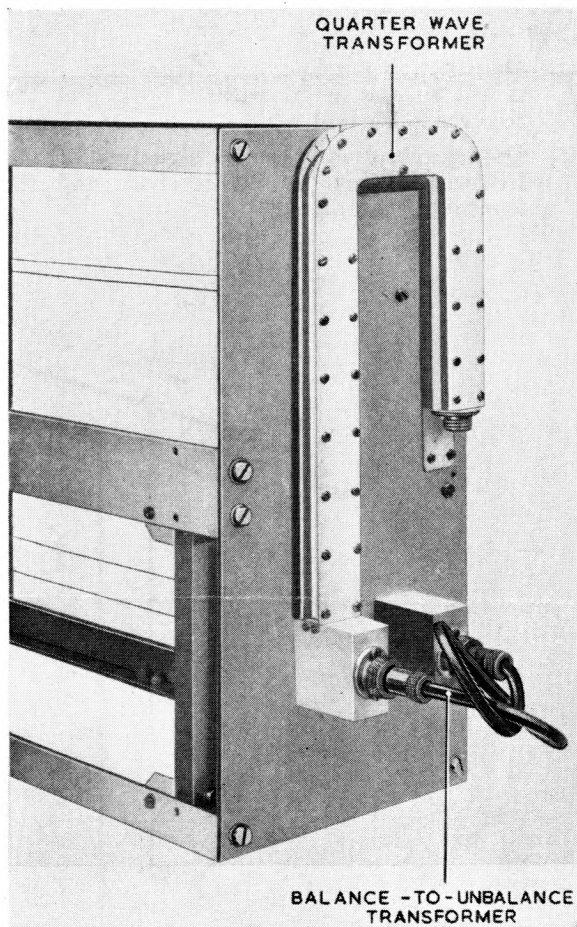


Fig. 4. End plate

The line DEF is short-circuited at F; a spark gap is connected across this line at E, to make DE and EF each $\lambda/4$ long. The operation of the unit is as follows :—

Transmitting condition

4. When the transmitter fires, the two spark gaps arc over and short-circuit the lines at B and E. AB and DE therefore become short-circuited $\lambda/4$ lines, and present a high impedance across the aerial feeder when viewed from points A and D. The high impedance at A prevents any power from the transmitter reaching the receiver at C, and this circuit forms the TR switch. Due to the high impedance of the $\lambda/4$ line DE, this line has no effect on the operation of the circuit and power is fed along the balanced feeder from the transmitter to the aerial.

Receiving condition

5. When the transmitter is quiescent, both spark gaps are open-circuited. The receiver is connected to the feeder via the $\lambda/2$ line ABC, which acts as a 1 to —1 transformer; therefore the points A and C have the same impedance and hence received signal voltage is fed from the aerial system via ABC to the input of the receiver.

6. The line DEF likewise forms a $\lambda/2$ linear transformer, and the short-circuit at F is transferred to D. The $\lambda/4$ section AD in the main feeder then functions as a short-circuited $\lambda/4$ line, presenting a high impedance at A, and effectively isolating the transmitter. Resonant lines used in this manner form a circuit known as a transmitter blocker.

Constructional details

7. The switch unit (*fig. 2*) is built into an open frame made of silver-plated brass. The resonant lines and spark gaps are supported by Mycalex and loaded polystyrene plates which are fixed to the frame; the frame is drilled so that the position of the plates can be adjusted if the operating frequency is changed. The loaded polystyrene plate at the front end of the frame supports the $\lambda/4$ length AD of the main feeder between the points of connection of the TR switch and the transmitter blocker, this length being bent into a U-shape to reduce the overall width of the unit. Two pairs of 20 S.W.G. phosphor-bronze wires form the resonant lines of the TR switch and the transmitter blocker; the ends of these wires pass through holes in the main feeder and are clamped under tension by 6 BA screws in blocks on the feeder. The phosphor-bronze wires have a spacing of 2 inches which gives a characteristic impedance of 565 ohms. These lines thus have a higher impedance than that of the main feeder (320 ohms). This is to increase the voltage developed across the spark gaps and ensure that the gaps fire rapidly at the beginning of the transmitter pulse, and to reduce the effective spark gap impedance during the pulse to give increased protection to the receiver.

8. The spark gaps (*fig. 3*) are of the open type having adjustable thoriated tungsten electrodes $\frac{1}{8}$ in. in diameter, and are mounted on a Mycalex plate at a suitable position along the resonant lines. A micrometer screw enables each gap to be set to its operating setting of between 0.01 in. and 0.015 in. The micrometer scale is calibrated with 25 divisions, each division representing 0.001 in.

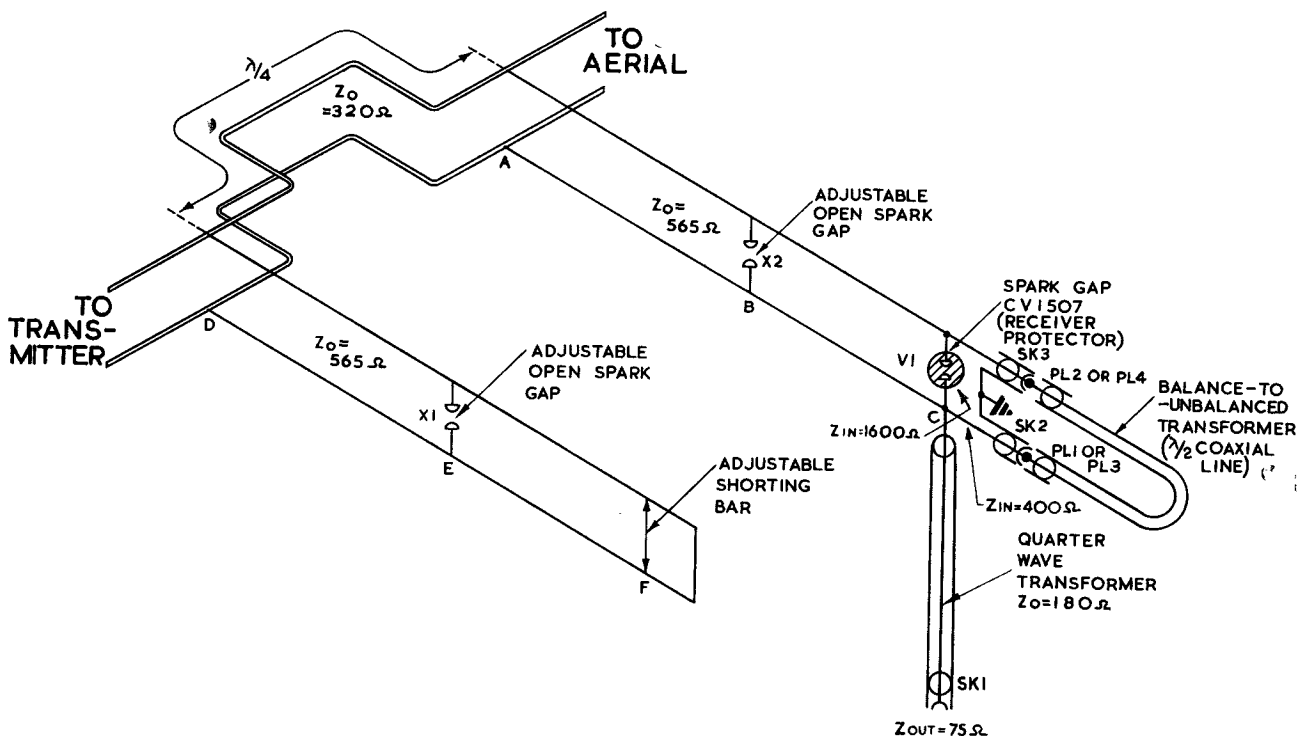


Fig. 5. Switch unit (T & R) Type 405, circuit

The gap is initially set up at 0.01 in., and it will then continue to operate satisfactorily until it is increased by wear to 0.015 in. when the gap will require resetting.

9. Provision is made for enclosed gaps (Type CV.1507) to be substituted for the open type if desired. The enclosed gaps are fitted in clips on the open spark gap mounting, the open gap electrode being screwed out sufficiently to prevent the open spark gap from operating. The life of the CV.1507 on full power is approximately 20 to 25 hours only, thus enclosed gaps should normally be used on low power, that is below 100 kW.

10. An enclosed type of spark gap is mounted on a loaded polystyrene plate and is connected across the end of the line ABC at the point when the receiver is connected. This is to protect the receiver should the TR spark gap fail.

11. The end of the $\lambda/2$ line connected to the receiver is terminated in coaxial sockets into which a $\lambda/2$ loop of coaxial line is fitted (*fig. 4*). The $\lambda/2$ loop acts as a balance-to-unbalance transformer between the line ABC and the unbalanced input to the receiver. Connection between one side of the balanced line and the feeder to the receiver is made through a $\lambda/4$ linear matching transformer, constructed of a square cross-section

coaxial line, mounted on the rear plate of the frame. Two separate loops of coaxial line are provided for use as balance-to-unbalance transformers, one (Stores Ref. 10HA/12823) for use at frequencies below 195 Mc/s and one (Stores Ref. 10HA/11151) for frequencies above 195 Mc/s.

Circuit description

12. The circuit of the switch unit is shown in *fig. 5*. The $\lambda/2$ lines ABC and DEF, each having a characteristic impedance of 565 ohms, are connected to the 320-ohm main feeder at A and D respectively. The line ABC is terminated at C by the $\lambda/2$ balance-to-unbalance transformer; the unbalanced line to the receiver is connected at C.

13. Theoretically, if the line ABC was $\lambda/2$ long, the 320-ohm resistive impedance of the main feeder would be transferred to C. The inclusion of the spark gaps, however, makes the impedance reactive at a point $\lambda/2$ from A, and to maintain the resistive impedance at C the line is physically lengthened. This increase in length raises the resistive impedance at C to 1600 ohms, which is reduced to 400 ohms by the $\lambda/2$ balance-to-unbalance transformer. This 400-ohm output impedance is matched to the 75-ohm input impedance of the receiver by the 180-ohm $\lambda/4$ matching transformer.

Chapter 3

CAPACITY SWITCH (SWITCH UNIT TYPE 506)

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Introduction

1. The capacity switch is employed for switching a feeder to a series of loads at the pulse recurrence frequency. It has particular application to switching an aerial feeder successively from one aerial or aerial system to another. In radar practice, when the same aerial system is used for transmission and reception, the connection to a particular aerial system must be maintained for a period sufficient to enable a pulse to be transmitted and a reflected pulse to be received from any aircraft at the maximum range before the feeder is switched to another aerial system.

Theoretical description

Capacity switch

2. Fundamentally the capacity switch consists of a constant speed rotor which carries a number of plates arranged to pass close to pairs of fixed plates (stators) set in apertures in the casing of the switch. The switching is effected by the change in capacitance of the capacitors formed by the stator and rotor plates as the rotor rotates. While the rotor plate completely covers one pair of stator plates, the capacitance remains constant and is of a high value; when it is clear of the stator plates, the capacitance is of a low value. Between these

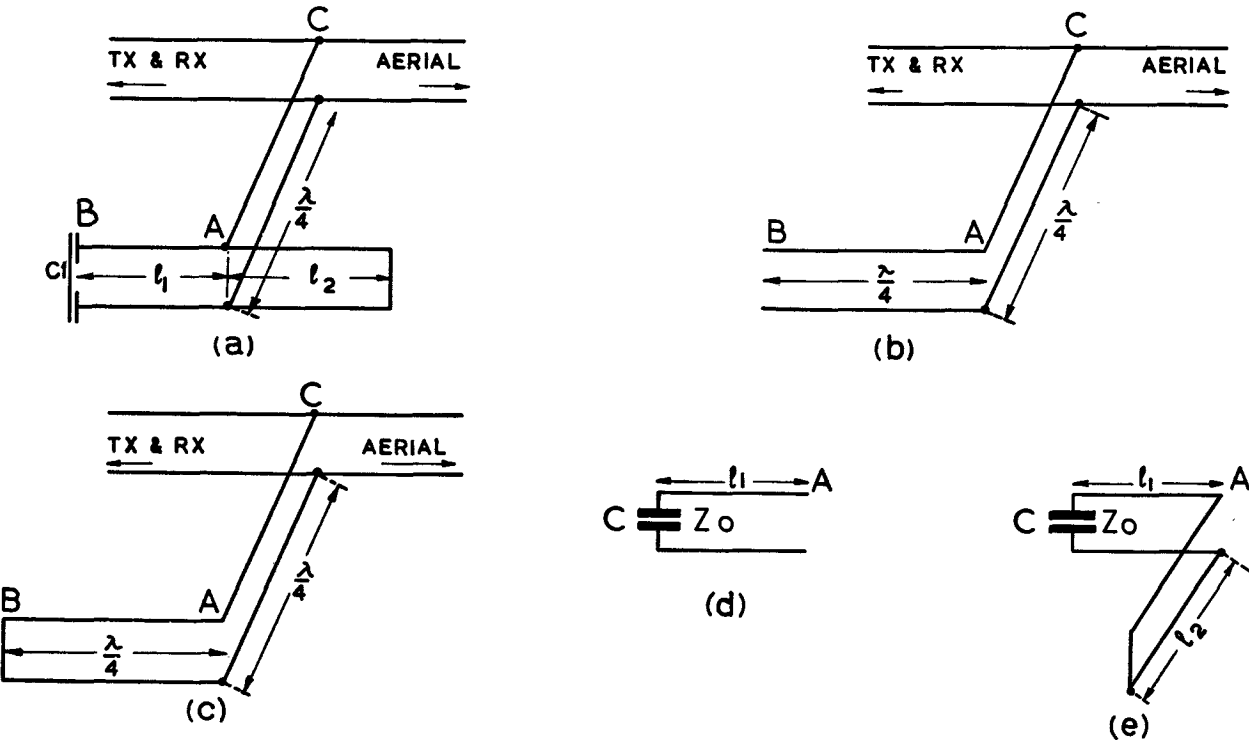
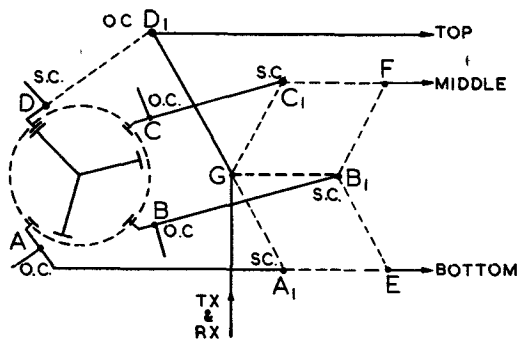
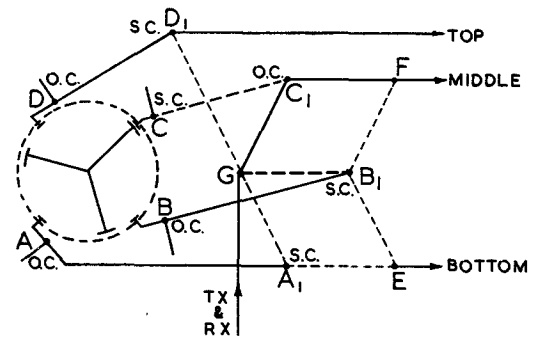


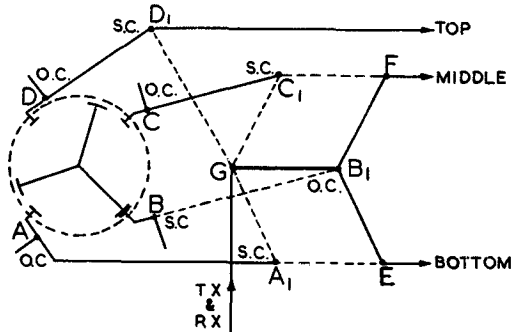
Fig. 1. Principles of single switching



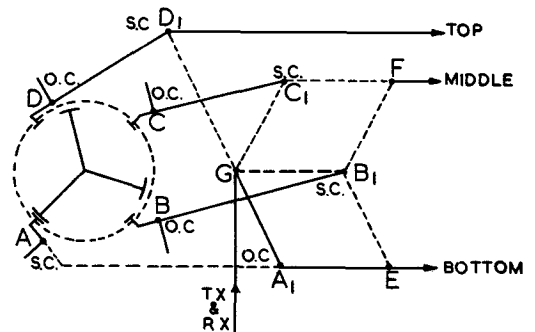
(a) SWITCH FEEDING TOP ARRAY



(b) SWITCH FEEDING MIDDLE ARRAY



(c) SWITCH FEEDING MIDDLE AND BOTTOM ARRAYS



(d) SWITCH FEEDING BOTTOM ARRAY

OC-OPEN CIRCUIT SC= SHORT CIRCUIT ----- REPRESENTS FEEDER EFFECTIVELY DISCONNECTED DUE TO SWITCHING ACTION.

Fig. 2. Multiple switching

conditions it will change slowly from the high value to the low value. The relation between the duration of the period of constant capacitance and the period of varying capacitance will depend upon the following factors:—

(1) The relation between the width of the rotor plate and that of the stator plates.

(2) The spacing between the edges of the stator plates and the edges of the aperture in the metal casing, since this spacing forms a discontinuity between the casing wall and the plates.

3. The manner in which the switching is effected by this change in capacitance is explained by reference to fig. 1, inset (a), which shows one of the feeders to the capacity switch. When the rotor plate is opposite the stator plates, a large capacitance C_1 exists at B; the length of line l_1 is so chosen that the effect of the large capacitance and the line l_1 at A is that of an open-circuited quarter-wavelength of line as shown in fig. 1, inset (b). Thus the impedance at A is very small, and the effect of the stub l_2 is neutralised. AC is a quarter-wave-line, and therefore BAC is one-half-wavelength long. This acts as a one-to-one transformer, and the high impedance at B is transferred to C, which effectively produces an open-circuit at this point.

4. When the rotor plate is clear of the stator plates C_1 is small. The total capacitance due to the stator plates and the length of line l_1 is tuned with

the inductive stub l_2 to give a parallel-tuned circuit which has an infinite impedance at the operational frequency, that is, equivalent to a short-circuited quarter-wavelength of line as shown in fig. 1, inset (c). The impedance at the point A is thus high and consequently the impedance at the point C is low.

5. The lengths l_1 and l_2 may be determined as follows. Consider the length of line l_1 having a characteristic impedance of Z_0 as shown in Fig. 1 (d). The impedance at A is given by:—

$$Z = jZ_0 \frac{Z_0 \tan \frac{2\pi l_1}{\lambda} - \frac{1}{C_0 \omega}}{Z_0 + \frac{1}{C_0 \omega} \tan \frac{2\pi l_1}{\lambda}}$$

From this expression it will be seen that $Z = 0$, that is a short-circuit is produced at A, when $\tan \frac{2\pi l_1}{\lambda} = \frac{1}{Z_0 C_1 \omega}$. Now suppose that l_1 is adjusted so that, with the large capacitance C_1 , the relation $\tan \frac{2\pi l_1}{\lambda} = \frac{1}{Z_0 C_1 \omega}$ is satisfied. When the capacitance is changed from C_1 to C_0 , the impedance at A is given by:—

$$Z = Z_1 = jZ_0 \frac{Z_0 \tan \frac{2\pi l_1}{\lambda} - \frac{1}{C_0 \omega}}{Z_0 + \frac{1}{C_0 \omega} \tan \frac{2\pi l_1}{\lambda}}$$

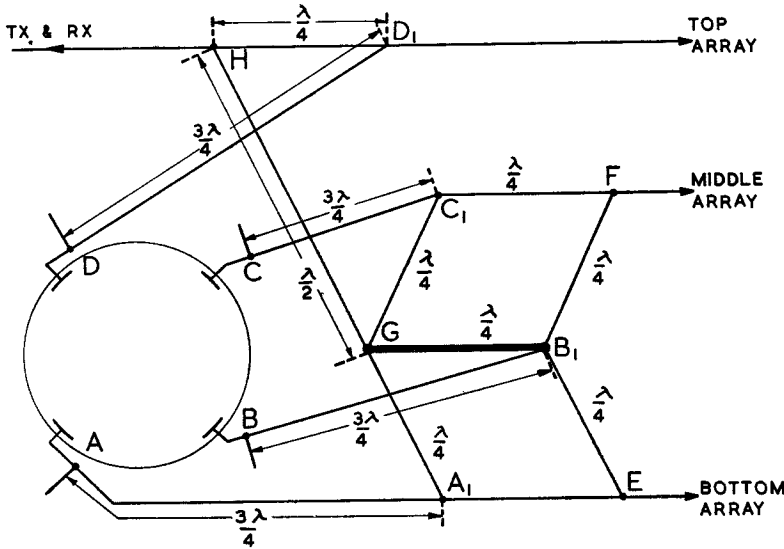


Fig. 3. Practical switching network

$$\begin{aligned}
 &= jZ_0 \frac{\frac{1}{C_1\omega} - \frac{1}{C_0\omega}}{Z_0 + \frac{1}{C_0\omega} \times \frac{1}{C_1\omega} \times \frac{1}{Z_0}} \\
 &= jZ_0^2 \frac{(C_0 - C_1)\omega}{1 + C_0C_1Z_0^2\omega^2}
 \end{aligned}$$

Now as $C_0 < C_1$, Z_1 will be negative, that is, Z_1 will be a capacitive impedance. For perfect switching an infinite impedance has to be produced at A when C_0 is present. This is achieved as described in para. 4 by connecting an inductive stub at A which by itself presents an impedance Z_s such that

$$\frac{1}{\frac{1}{Z_1} + \frac{1}{Z_s}} = \infty$$

That is, $Z_s = -Z_1$

A short-circuited stub of length l_2 presents an impedance given by:—

$$Z_s = jZ_0 \tan \frac{2\pi l_2}{\lambda}$$

so that the condition $Z_s = -Z_1$ gives

$$Z_0 \tan \frac{2\pi l_2}{\lambda} = \frac{Z_0^2(C_1 - C_0)\omega}{1 + C_0C_1\omega^2Z_0^2}$$

and since the right-hand expression is positive, $\frac{2\pi l_2}{\lambda}$ will be between 0 and $\frac{\pi}{2}$ and hence $0 < l_2 < \frac{\lambda}{4}$.

Thus with the stub system shown in fig. 1 (e), it is possible to arrange that the impedance at A changes from 0 to ∞ as C changes from C_1 to C_0 provided that

$$\begin{aligned}
 \tan \frac{2\pi l_1}{\lambda} &= \frac{1}{Z_0C_1\omega} \\
 \text{and } \tan \frac{2\pi l_2}{\lambda} &= \frac{Z_0(C_1 - C_0)\omega}{(1 + C_1C_0\omega^2Z_0^2)}
 \end{aligned}$$

In practice the values of l_1 and l_2 may be calculated much more quickly by the use of circle diagrams. It is found that the values calculated in this way

are sufficiently accurate for most practical work, agreeing reasonably well with the values obtained using an impedance measuring set or a standing-wave indicator.

6. Any practical switch using the above principle will suffer from the disadvantage that there will inevitably be a period in the operation during which the capacity is changing from one value to another, and thus there is neither an open circuit not a short circuit at the switching point. This disadvantage is overcome by locking the transmitter pulse and receiver timebase to the operation of the switch so that the transmitter pulse occurs at the beginning of a constant capacity period, and the period during which the capacity changes occurs in the 'blackout' time between the end

of one receiver timebase and the next transmitter pulse.

Feeder system

7. So far, the description has been limited to a consideration of a single switching point. In radar 7 Mk. 2 and 3, four switching points are employed and four aerial systems are controlled. These aerial systems are switched in the order top, middle, middle + bottom and bottom. The capacity switch comprises four pairs of stator plates and three rotor plates, the rotor consisting of three arms with one plate fixed to the end of each arm. This reduces the speed of rotation and also provides a balanced construction for the rotor. The four pairs of stator plates are spaced apart by 90 deg. and the three rotor arms are spaced by 120 deg.

8. The arrangement is shown diagrammatically in fig. 2. Thus referring to fig. 2 (a), the four switching points are indicated by A, B, C and D and correspond to the junction of l_1 and l_2 in fig. 1 (a). These switching points are connected to a switching network at points A_1 , B_1 , C_1 and D_1 the lengths of line between points A, A_1 and so on being $\frac{\lambda}{4}$. The lengths of the lines GA_1 , GB_1 , GC_1 , GD_1 , C_1F , A_1E , B_1F and B_1E are all $\frac{\lambda}{4}$, GB_1 being a 2 to 1 transformer. As the rotor plate is opposite the stator plates at the point D, the capacity at this point is a maximum; therefore the impedance at D is low and that at D_1 is high. At the points A, B and C however, the capacity is a minimum; the impedance at these points will be high and that at the points A_1 , B_1 and C_1 will be low. Power from the transmitter is fed to the point G where it has four possible paths, each controlled by a switching point. As the impedance at the points A_1 , B_1 and C_1 is low, the effective impedances at G looking in the directions GA_1 , GB_1 and GC_1 will be high. On the other hand, as the impedance at the point D_1 is high, the

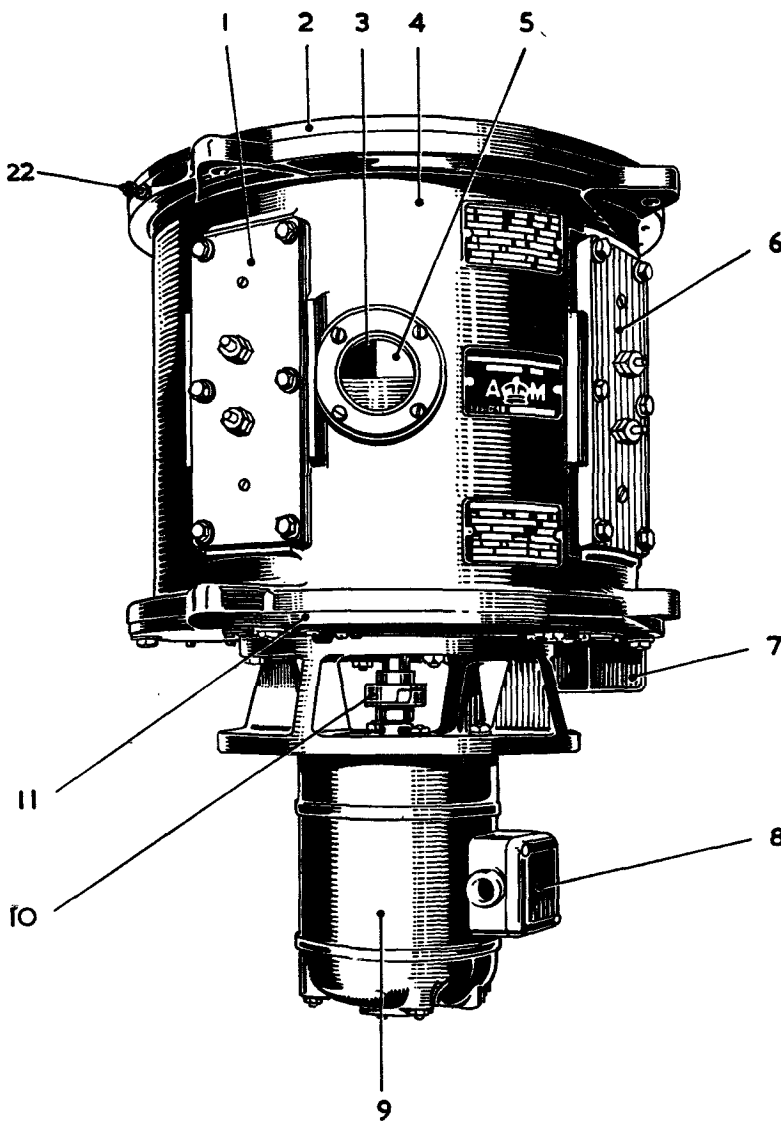


Fig. 4. Exterior view of capacity switch

impedance at G in the direction GD_1 is low and power is fed along this branch to the top aerial. The rotor rotates in a counter-clockwise direction as regards the illustration and consequently the next pair of stator plates to be covered by a rotor plate will be those at the point C. By similar reasoning to that employed for the point D, it will be seen that the power is passed along the lines GC_1F to the middle aerial as shown in fig. 2 inset (b). In the next position the stator plates at the point B (fig. 2 inset (c)) are covered and power will be fed along the line GB_1 , where it divides to energize the middle and bottom aerials in parallel along the lines B_1F and B_1E . Finally in the fourth position the stator plates at the point A in fig. 2, inset (d) are covered and power is fed to the bottom aerial along GA_1E .

9. It is not possible, in practice, to employ the switching network shown

in fig. 2 owing to the difficulty in arranging the lines AA_1 etc., of the correct length. The practical arrangement is shown diagrammatically in fig. 3 from which it will be seen that the branching point to which power is fed is the point H. The lengths HD_1 and HG are $\frac{\lambda}{4}$ and $\frac{\lambda}{2}$ respectively, while AA_1 , BB_1 , CC_1 and DD_1 , are now $\frac{3\lambda}{4}$, these lengths

having the same effect as a $\frac{\lambda}{4}$ length of line. Assuming that the impedance at D_1 in the direction HD_1 is high and that at the points A_1 , B_1 and C_1 is low, then the impedance at G looking along GC_1 , GB_1 , and GA_1 is high so that the impedance at H looking along HG is also high. Further the impedance at H looking along HD_1 is low and hence power is fed to the top aerial. When the impedance at D_1 is low the impedance at one of the points A_1 , B_1 and C_1 will be high, giving a low impedance at G as regards that one direction. This low impedance is transferred to the point H and hence, as the impedance at H looking along HD_1 is high, power is fed along HG and thence along the low impedance path to the appropriate aerial.

Constructional details

Capacity switch

10. A general view of the capacity switch is shown in fig. 4. The switch consists of a cylindrical metal

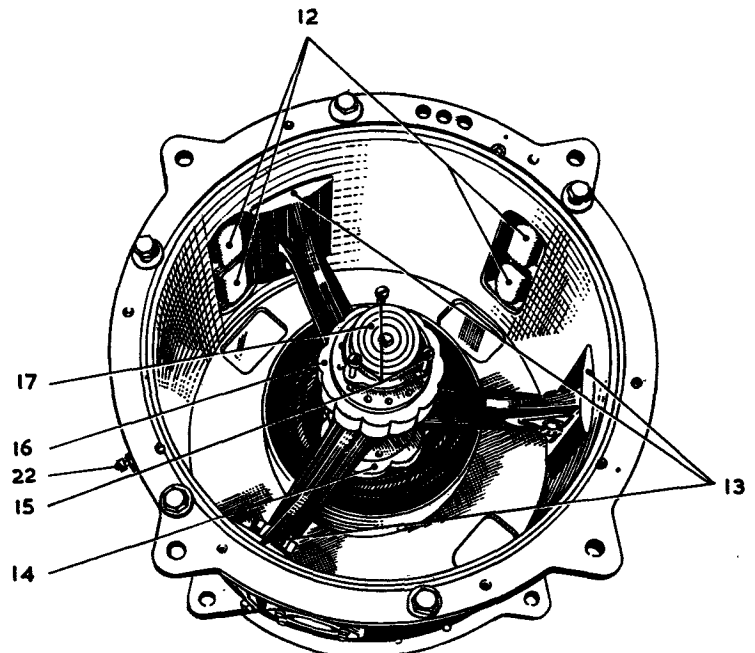
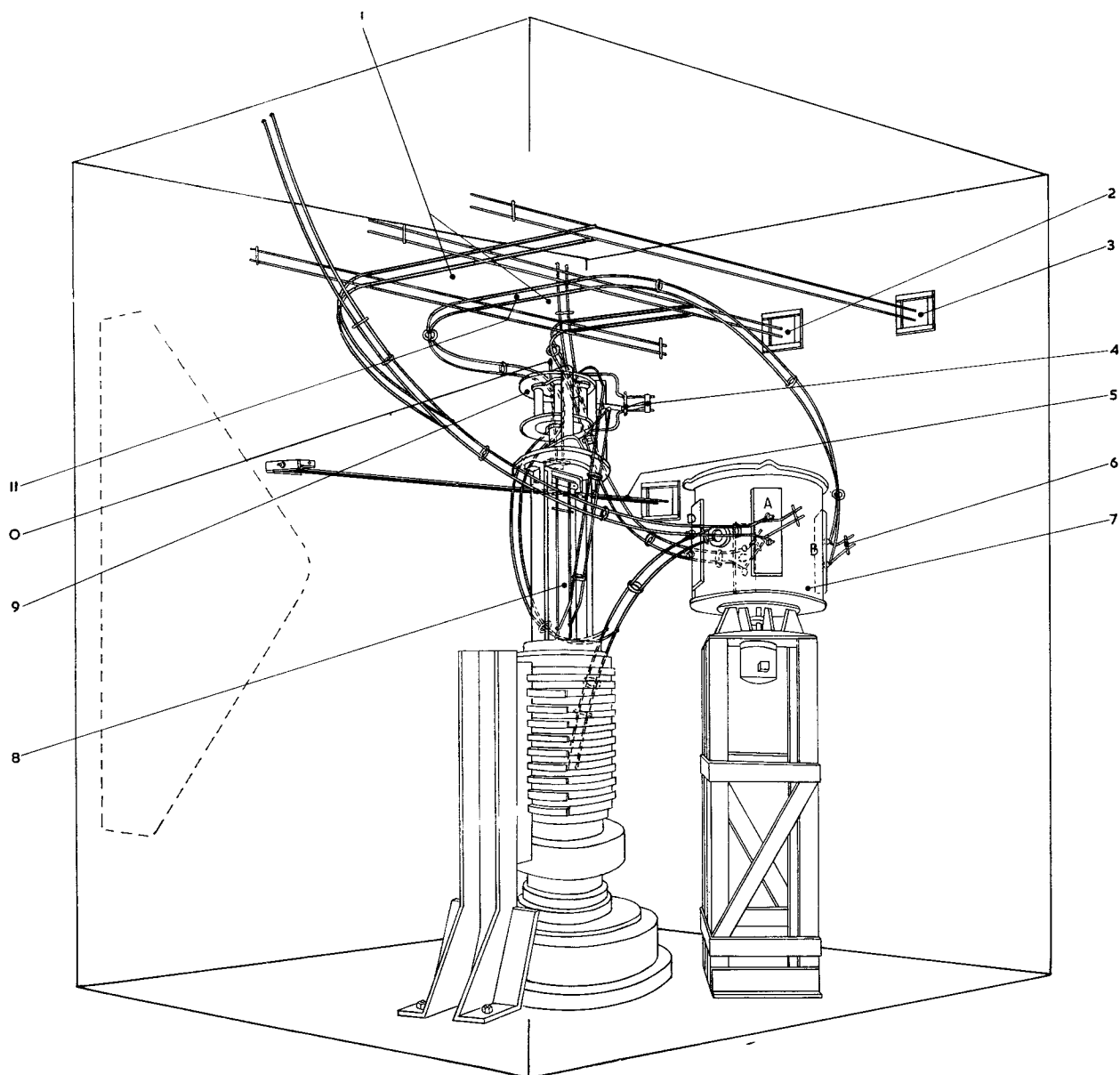


Fig. 5. Capacity switch—internal view



KEY

- | | |
|------------------------------------|---------------------------------|
| 1. FEEDER SWITCHING NETWORK | 7. CAPACITY SWITCH |
| 2. FEEDER TO MIDDLE ARRAY | 8. FEEDER FROM TRANSMITTER WELL |
| 3. FEEDER TO BOTTOM ARRAY | 9. ROTATING CAPACITY COUPLING |
| 4. INDUCTIVE STUB | 10. CONSTANT IMPEDANCE TAPER |
| 5. FEEDER TO TOP ARRAY | 11. $\pi/4$ TRANSFORMER 2:1 |
| 6. CAPACITY SWITCH CORRECTION STUB | |

Fig. 6. Feeder runs in capacity switch cubicle

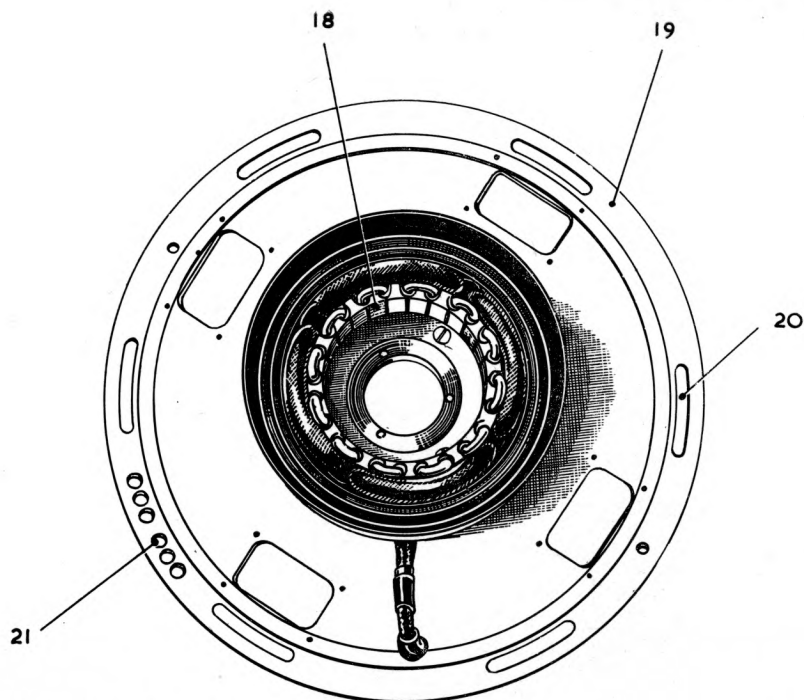


Fig. 7. Capacity switch cover plate

casing (4) having four apertures through which the pairs of stator plates are inserted. Each pair of stator plates is mounted on a Mycalex insulating plate of which two (1, 6) are shown, the plates being mounted one over each aperture. An observation window (3) provided in the casing permits the operation of the rotor to be checked; the edge of one of the rotor plates (5) can be seen in fig. 4. The shaft of the driving motor (9) is connected to the rotor shaft by a flexible coupling (10); the power supply leads to the motor are taken through a junction box (8) mounted on the motor casing. The remaining leads for the capacity switch are carried through a junction box (7) mounted on the lower cover plate of the switch.

II. A view of the interior of the capacity switch with the upper cover plate removed is shown in fig. 5. The rotor spindle is carried in ball bearings of which one only (17) is shown in the diagram. The outer race of this bearing is seated in the cover plate which has been removed. The three bolts (15) serve to secure the outer race in position in the cover plate. The three rotor plates (13) and two pairs of stator plates (12) are shown in the illustration. Each stator assembly consists of a pair of

plates 2.75 in. $\times$ 1.00 in. spaced 1 in. apart. Each rotor plate is 6.25 in. $\times$ 2.8 in. and has a radius of curvature of 6.5 in. The spacing between the rotor and stator plates, 0.018 in., gives a maximum capacity between stator plates of approximately 12pF + 10 per cent. - 0 per cent. The capacity of stator plates when not covered by the rotor is about 3 pF + 0 per cent. - 5 per cent. The edges of the stator plates of the apertures in the outer case are rounded to prevent corona and arcing and this radius reduces the effective width of the stator plates to 0.8 in.

12. Each stator plate will be covered by a rotor plate three times in one complete revolution of the rotor and hence there will be twelve switching operations during each complete

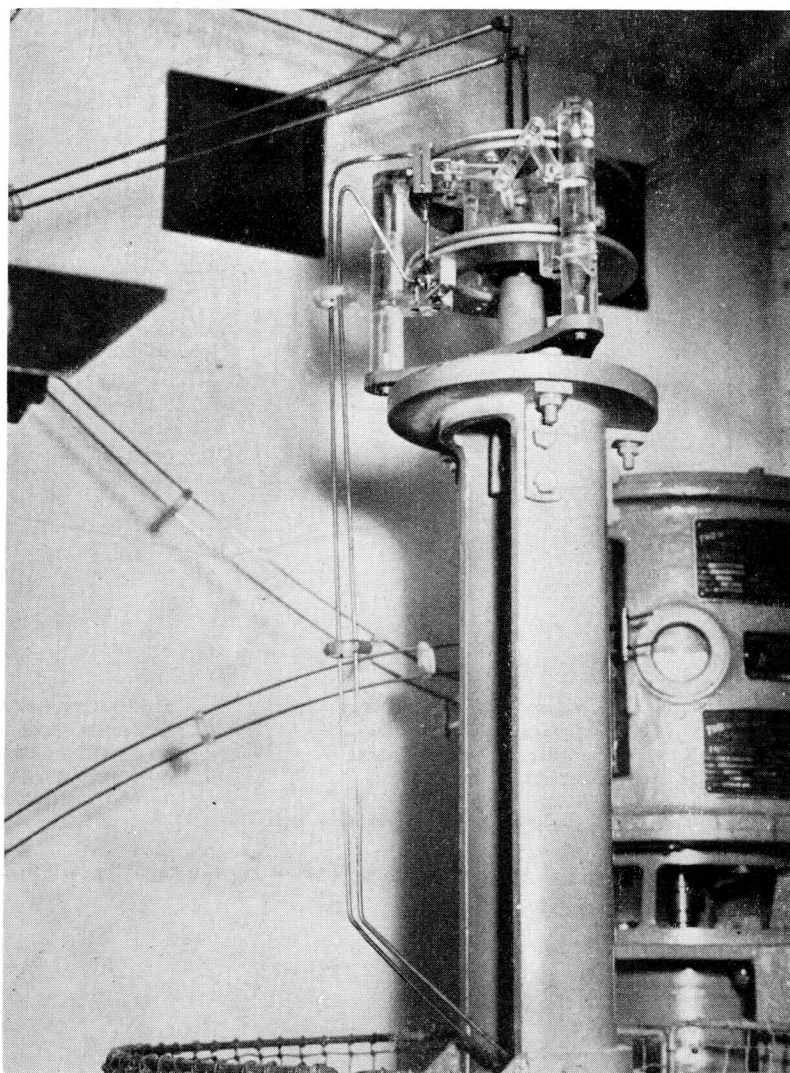


Fig. 8. Interior of cubicle

revolution. The complete circumference of the rotor is 40.8 in. and hence each rotor plate will move $\frac{40.8}{12} = 3.4$ in. between successive transmitter pulses. As each rotor plate is 2.8 in. wide and as the effective width of each stator plate is 0.8 in. wide, the high capacitance between stator plates will exist for a movement of 2 in. of rotor, that is, for $\frac{2}{3.4}$ or .59 of the interval between transmitter pulses. The time interval between successive transmitter pulses corresponds to a range of 372 miles at a recurrence frequency of 250 c/s and is proportionately larger at lower frequencies. This means that if the transmitter pulse is arranged to occur at the beginning of each high capacity period, then this period will occupy the first $372 \times .59 = 220$ miles of each receiver timebase sweep, which is thus the maximum range of the station.

Driving motor

13. The driving motor on the switch consists of a 1/2 h.p. two-pole AC induction motor driven from a special alternator set which provides three-phase AC at a frequency variable from 15 to 30 c/s. This gives a range of speed from 900 to 1,800 r.p.m. which, with twelve switching operations per revolution, gives a recurrence frequency range from 180 to 360 c/s.

Feeder system

14. All the feeders associated with the capacity switch are of standard dimensions (300 lb. copper wire at 1 in. centres) except the length GB₁ which is made from two $\frac{5}{16}$ in. brass rods at approximately 1 in. centres. As the output from the coupling unit is $\frac{1}{4}$ in. tube at 2 in. centres, a constant impedance

taper feeder section is introduced between the coupling unit and the cubicle feeder network. The layout of the feeder runs in the capacity switch cubicle is shown in fig. 6.

Alternators

15. The capacity switch is provided with two alternators; one generates a single-phase sine wave and the second generates four sine waves in phase quadrature. The first alternator generates a sine wave having a frequency which is twelve times that of the rotation of the switch shaft that is, the pulse recurrence frequency of the installation (nominally 250 c/s). The rotor (16) of this alternator is shown in fig. 5. This sine wave is employed for locking the transmitter and receiver to the rotation of the switch.

16. The second alternator generates four sine waves in phase quadrature each having a frequency equal to three times that of the rotation of the switch shaft, that is, nominally 62.5 c/s. The rotor of this alternator, shown in fig. 5 (14), is mounted on the opposite end of the switch shaft to the rotor of the single phase alternator and the stator is mounted in the cover plate (11) fig. 4. The top cover plate (fig. 7) which carries the stator (18) of the single-phase alternator is fixed to the main casing of the switch by bolts which pass through slots (20) in the end plate (19). This enables the angular position of the stator of the alternator to be adjusted relative to the position of the capacity switch stator plates and hence enables the phase of the alternator output to be adjusted. Tommy holes (21) are provided in the cover plate to facilitate this adjustment. The locking screw (22) must be slackened while the top cover plate is being moved and tightened again before switching on the transmitter.

SECTION 5

RADAR TYPE 79 Mk. I (IFF)

Chapter I

GENERAL DESCRIPTION

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Introduction

1. Radar Type 7, Mk. 3 is fitted with IFF Mk. 3G. The IFF (Radar Type 79 Mk. 1) is installed in a rotatable cabin and operated by remote control from the operations centre. The IFF aerial array is mounted on top of the cabin, which rotates in synchronism with the primary radar array. The rotating cabin is mounted on a standard plinth which houses a termination panel and part of the turning gear.

Function of IFF Mk. 3G

2. IFF Mk. 3G enables a GCI station to obtain, on request, an identifying signal from an aircraft under its control. The system works on a fixed frequency in the IFF G-band.

3. When identification is required, the IFF transmitter is switched on from the radar console. Simultaneously the pilot of the aircraft is requested to switch the airborne transponder to the G-band. The transponder operates on the G-band for 20 seconds only, after which time it is automatically switched back to the normal (A-band) condition.

4. If the IFF aerial array is rotating at a speed of 6 r.p.m. a response will thus be seen for two revolutions. The response consists of pulses of 12 μ s duration, transmitted for periods of one twenty-fifth of a second with one-tenth second intervals.

5. G-band responses are displayed on the PPI console (console Type 64) as radial spokes on the outward side of the paint representing the interrogated aircraft. Due to a small delay period in the IFF

system, caused mainly by the transponder, the IFF response occurs approximately one mile behind the associated radar echo.

6. A block diagram illustrating the principles of IFF interrogation and reception involved in radar Type 79, Mk. 1 is shown in fig. 1.

General description

7. The equipment contained in the cabin may be sub-divided into two groups:—

- (1) Control and turning gear,
- (2) IFF equipment.

Control and turning gear

8. The control and turning gear consists of the following units:—

(1) Pivot mount. This forms the cabin mounting; it contains the turning motor (driven from an amplidyne generator located in the plinth) and gearbox for rotating the cabin, and the slip-ring unit through which external circuits are connected to the cabin equipment.

(2) Control unit (training) Type 602. This unit enables the rotation of the cabin to be controlled either locally or from a remote point.

(3) Control panel Type 621. This panel serves mainly as a distribution point between the incoming supplies to the cabin and the cabin equipment. The unit also delivers a 50V DC supply for operating the remote control relay of the IFF transmitter.

(4) Rectifier Type 67. This unit delivers a 200V DC supply to energize the field of the cabin turning motor.

9. Brief details of the cabin turning gear and control equipment are given in Sect. 1, Chap. 3. A detailed description will be found in Air Publication 2527B, Vol. 1, Part 1, Sect. 2.

IFF Equipment

10. A list of the equipment constituting the IFF installation is given in Table 1. The disposition of the equipment is as follows:—

- (1) Units mounted exterior to the cabin:—

Aerial and feeder system, which includes:—

Aerial frame Type 107
Aerial rods Type 288
Aerial rods Type 345
Aerial feeders Type 146
Aerial transformer Type 6
Moulded connectors Type 3367/1

- (2) Units mounted on the cabin wall:—

Aerial connector panel
Switch unit Type 271
Matching unit Type 28

- (3) Units mounted in an apparatus rack:—

Transmitter Type T.3686
Modulator Type 239
Amplifier Type A.3687
Rectifier Type R.3684
Monitor Type 61
Junction box Type 367.

TABLE I
IFF equipment

Unit	Type No.	Quantity	Stores Ref.
Rod, aerial	288	8	10BB/3664
Rod, aerial	345	1	10BB/6701
Frame, aerial	107	1	10BB/6842
Feeder, aerial	146	4	10BB/3657
Transformer, aerial	6	1	10BB/3662
Connector, moulded	3367/1	2	—
Aerial connector panel		1	—
Switch unit	271	1	10FB/6247
Matching unit	28	1	10AB/8538
Transmitter	T.3686	1	10D/18316
Modulator	239	1	10D/18598
Amplifier	A.3687	1	10U/16030
Receiver	R.3684	1	10D/18314
Monitor	61	1	10T/6133
Junction box	367	1	10D/18529
Connector set		1	—

Aerial and feeder system

11. The aerial (*Chap. 4*) consists of an 8-element vertically-polarized broadside array; the individual elements are end-fed unipoles mounted in front of an L-shaped frame, which constitutes a reflector and earth screen.

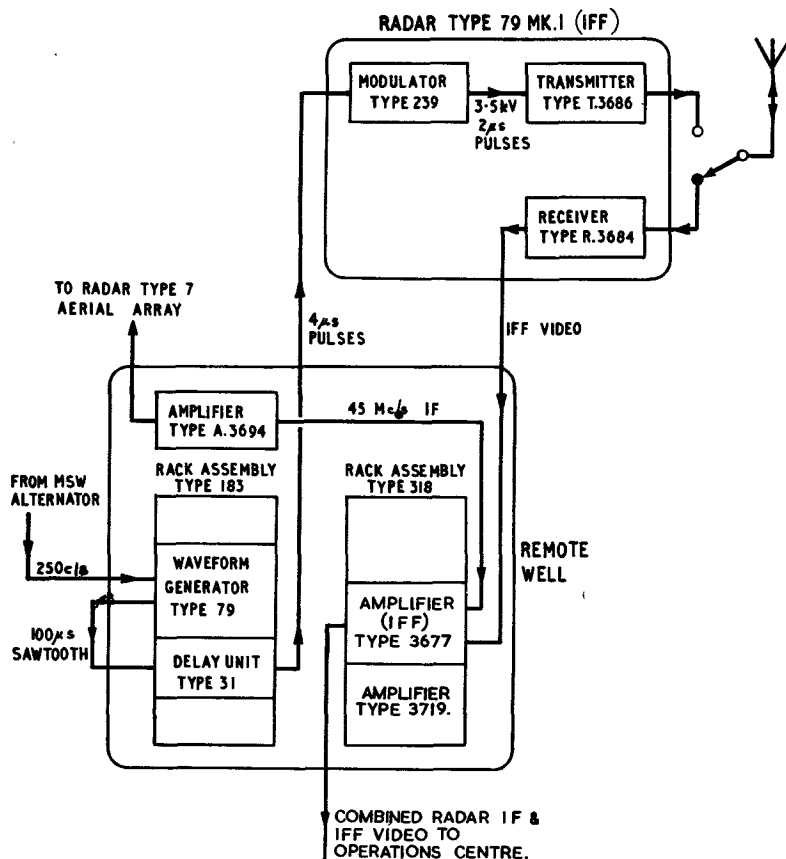


Fig. 1. IFF on radar Type 7, Mk. 3—block diagram

12. The feeder system is unbalanced. The eight elements of the aerial array are connected in pairs to an impedance matching transformer, and thence via a feeder to the aerial connector panel mounted on the cabin wall; the connector panel provides a feed-through connection between the external feeder and the internal feeder to the equipment.

13. A single vertical unipole is employed as a pick-up aerial to monitor the output of the transmitter. The aerial is connected through an unbalanced feeder to an RF voltmeter in the transmitter, and enables comparative measurements of RF power output to be made.

Switch unit

14. The T/R switch unit (*Chap. 4*) is of a spark-gap type. When the interrogator transmitter is triggered the spark gaps fire; this action automatically changes over the aerial system from receiver to transmitter.

Matching unit

15. The matching unit (*Chap. 4*) functions as an impedance matching transformer and an unbalance-to-balance transformer between the unbalanced feeder system and the balanced output circuit of the transmitter.

Transmitter and modulator

16. Transmitter Type T.3686 (*Chap. 2*) is the standard pulse interrogator used in IFF Mk. 3G applications. The transmitter has a peak power output of 10kW in 2μs pulses with a recurrence

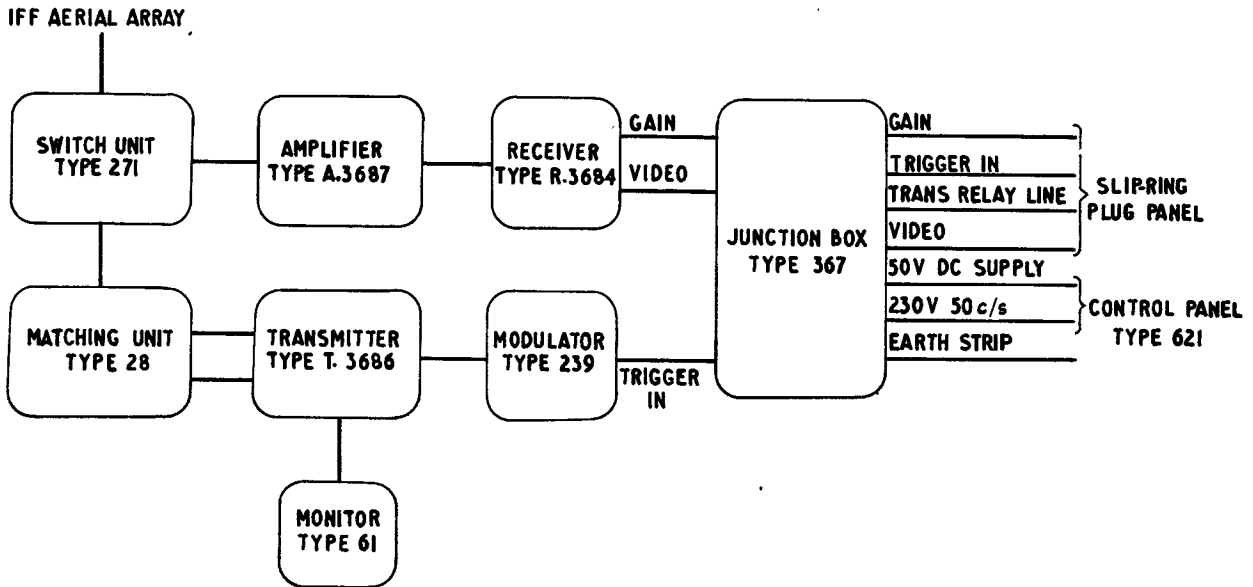


Fig. 2. Radar Type 79 Mk. I—block diagram

frequency of 250; it is normally quiescent and is remotely controlled from the radar console for periods of interrogation.

17. Modulator Type 239 (*Chap. 2*) supplies pulsed HT to the IFF transmitter. The unit operates from external triggering pulses and delivers pulsed HT to the transmitter. The peak power output is 50kW in $2\mu\text{s}$ pulses.

Receiver and amplifier

18. Receiver Type R.3684 (*Chap. 3*) is the standard- G-band pulse receiver. The receiver is preceded by an RF pre-amplifier, amplifier Type A.3687. The amplifier is necessary to increase the gain of the receiving system in view of the relatively long distances over which G-band responses are received, consequent upon the high transmitter power employed.

Monitor

19. Monitor Type 61 (*Chap. 4*) is a test instrument used to observe the pulse shape of the IFF transmitter and modulator under test conditions. It will measure pulse duration to an accuracy of $0.5\mu\text{s}$ and will give a visual indication on a CRT of a shape of both DC and RF pulses.

Junction Box

20. The junction box (*Chap. 4*) serves as a mains distribution panel and as a junction panel between the rack-mounted equipment and the cabin wiring. The box also houses a video matching transformer Type 2663 and a local gain control. The gain control is used for receiver testing.

21. The box incorporates a plug and socket change-over system for changing from IFF Mk. 3A to Mk. 3G in installations where both marks of IFF are fitted. In the present application the cable-mounted change-over socket is permanently connected to the plug designated G-BAND on the box.

Connector set

22. All internal inter-unit cabling, including RF feeders, is provided by the connector set (*Chap. 4*).

Principles of operation

23. A block diagram of the IFF installation is shown in fig. 2 to which reference should be made when reading the following paragraphs.

24. A 250 c/s sine-wave voltage derived from the MSW alternator in the capacity switch (*Section 4, Chap. 3*) is applied to the waveform generator Type 79; this unit forms part of rack assembly Type 183 or 183A located in the remote radar well. The output of the waveform generator, in the form of a positive-going sawtooth voltage, is applied to a delay unit Type 31, mounted in the same rack assembly.

25. The delay unit converts the sawtooth voltage from the waveform generator into a train of positive-going $4\mu\text{s}$ pulses. The leading edge of each of these pulses is delayed by a pre-determined time on the start of the sawtooth voltage producing it; in practice the pulse is normally delayed by a period of $40\mu\text{s}$.

26. The $4\mu\text{s}$ pulses are applied to the input of the IFF modulator Type 239 located in the radar Type 79 cabin. The pulses trigger the modulator to give output pulses having an amplitude of 3.5kV and a duration of $2\mu\text{s}$, delayed by $40\mu\text{s}$ on the input triggering pulse. The output of the modulator is applied as pulsed HT to fire the IFF interrogator transmitter Type T.3686. The transmitter and modulator are normally quiescent, and are switched on for periods of interrogation by remote control from the radar console; the action of switching on places an earth on the relay switching line, the remote control relays in the transmitter and modulator being operated from the 50V DC supply obtained from the control unit Type 621 (*para. 36*).

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27. The balanced RF output circuit of the transmitter is coupled to the unbalanced TR switch through a matching unit. The output of the transmitter fires the spark gaps in the switch unit, which changes over the aerial system from the input of the receiving circuit to the output circuit of the transmitter.

Receiving condition

28. In this condition the aerial system is connected through the TR switch to the input of the RF pre-amplifier (amplifier Type A.3687). Amplified RF pulses from the amplifier are applied to the input circuit of the receiver Type R.3684. The video output pulses are fed through the impedance matching transformer in the junction box, and via the slip-ring plug panel to the well.

29. In the well, the signals are amplified and limited in the amplifier Type A.3677 and fed to the amplifier Type A.3719 where they are mixed with radar signals (at IF) for feeding from the remote well to the operations centre over coaxial cable.

30. The gain control circuit of the receiver is extended via the junction box, cabin wiring and the slip-ring plug panel to the transmitter well (rack assembly Type 318 or 318A) where it provides a remote gain control facility.

Power supplies

31. The IFF equipment operates from a 200V to 250V, 45 to 65 c/s single-phase supply. The supply

to the IFF rack is taken via the cabin cableform from the sockets SK4/10 and SK4/12 on control panel 621 to plug PL19/11 and PL19/12 on junction box Type 367.

32. The 50V DC supply and earth return circuits are taken from SK5/ on the control panel and the earth strip and routed via the cabin cableform to PL19/5 and PL19/1 respectively on the junction box.

Slip-ring connections

33. Connections between the junction box and the four slip-rings used for IFF services are shown in Table 2.

TABLE 2
IFF connections (slip-rings)

Junction Box	Slip-ring plug panel	Slip-ring number	Service
SK7	SK8	9	Trigger in
SK8	SK9	10	Video
SK9	SK10	11	Gain
SK10	SK11	48	Transmitter relay
—	SK13/A	1	{ 230V AC to CU621
—	SK13/B	2	

Inter-unit connections

34. The inter-unit cabling of radar Type 79, Mk. 1 is shown in fig. 3 and 4.

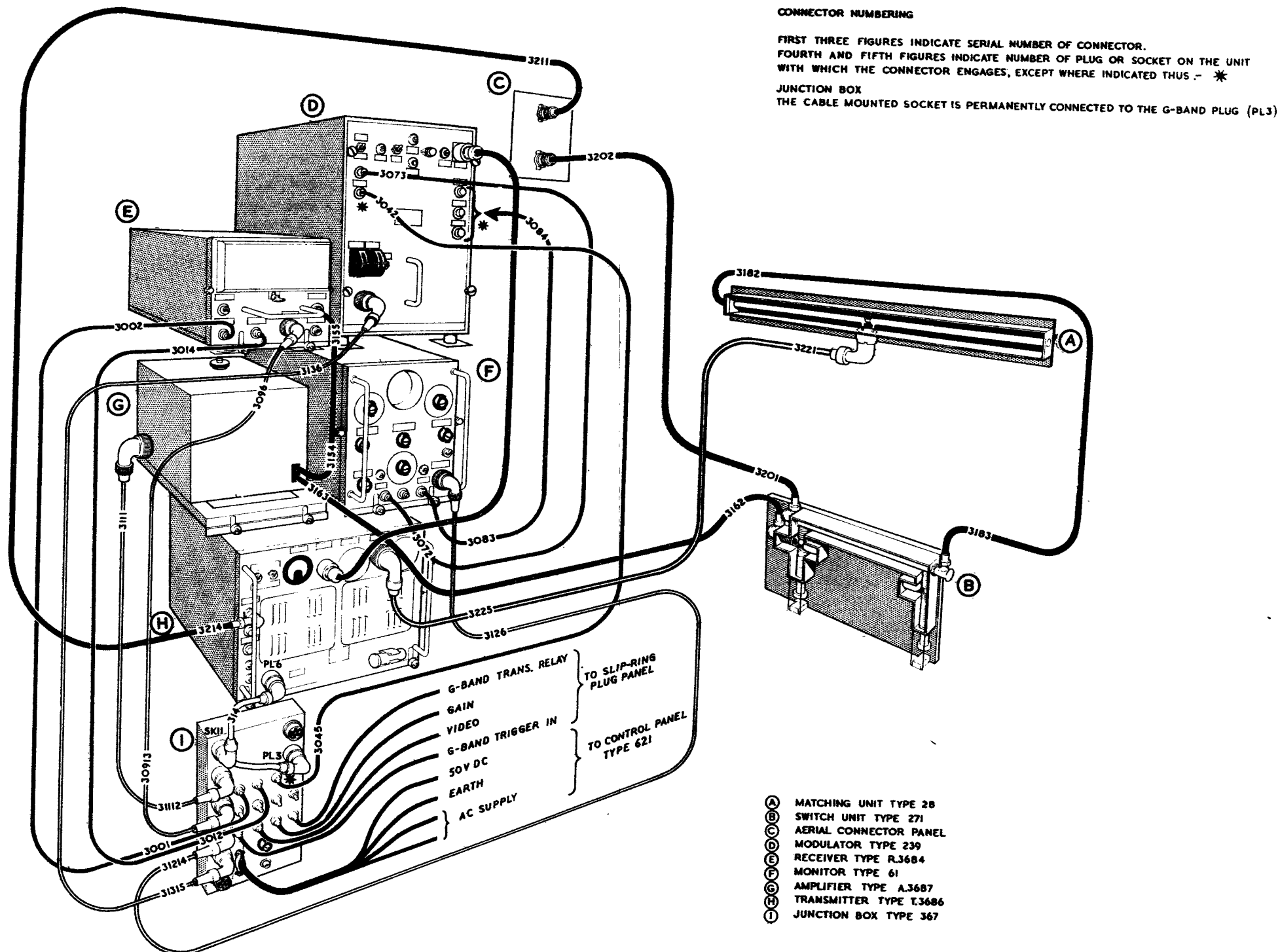


Fig.3.

Fig.3.

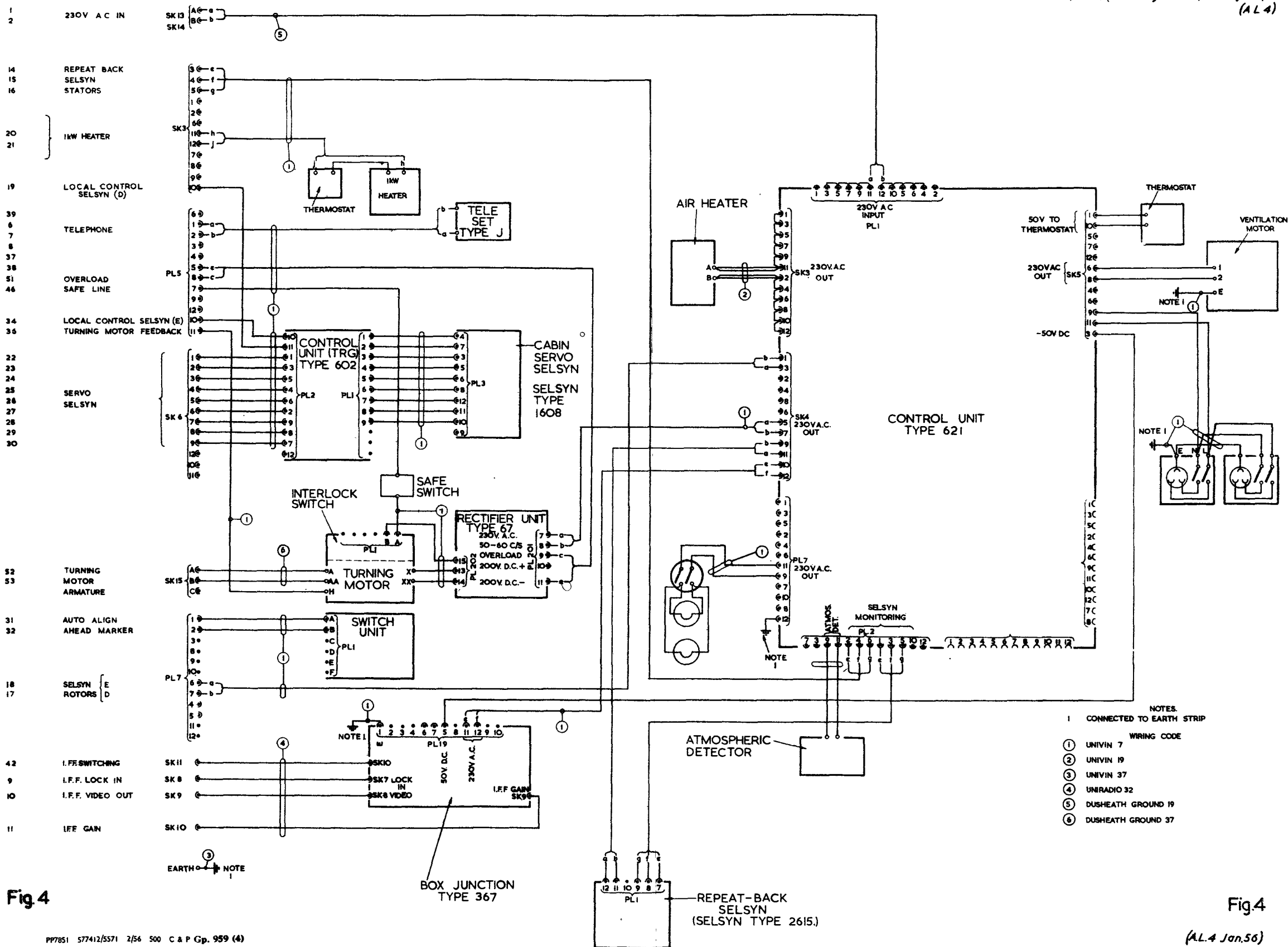


Fig. 4

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Chapter 2

TRANSMITTER TYPE T.3686 AND MODULATOR TYPE 239

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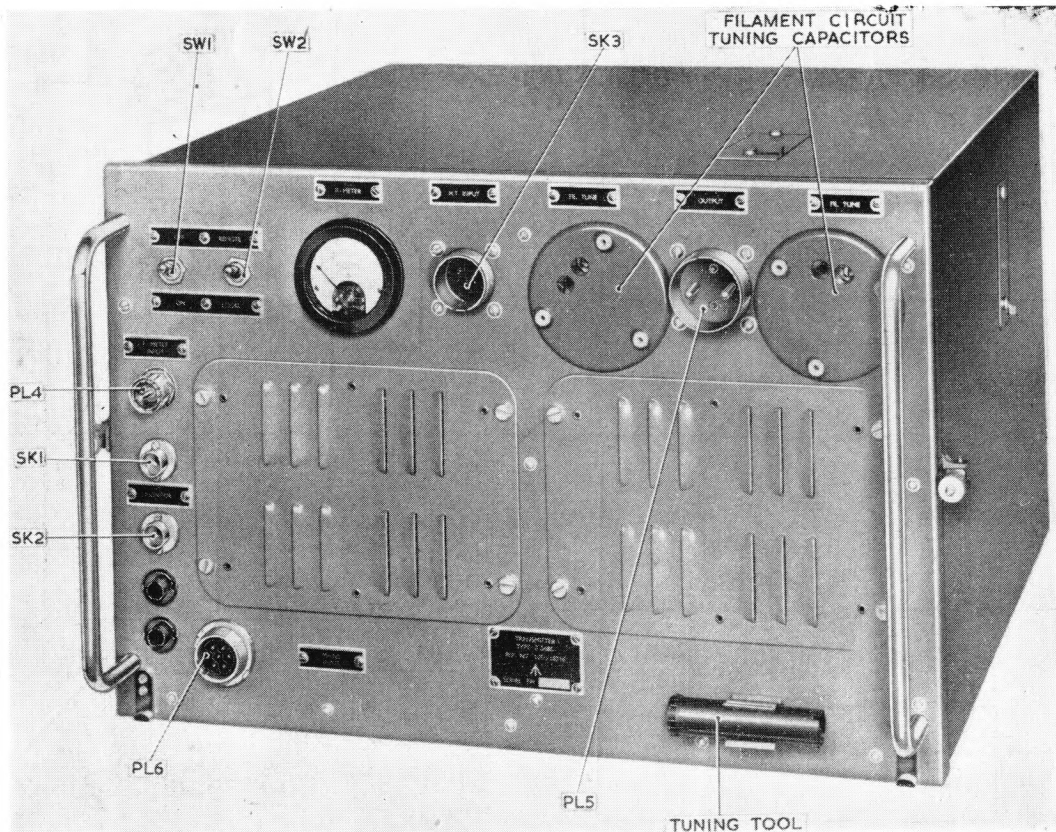


Fig. 1. Transmitter Type T.3686

TRANSMITTER TYPE T.3686

1. Transmitter Type T.3686 (Stores Ref. 10D/18316) is a pulse interrogator employed in fixed and mobile IFF Mk. 3G installations. The transmitter consists essentially of an RF oscillator, which has a frequency coverage of 180 to 220 Mc/s, and is normally operated on a spot frequency of 209 Mc/s. The peak power output is 10kW in 2 μ s pulses with a recurrence frequency of 250 or 500.

2. When operational, the transmitter is continuously pulsed by an external modulator; the transmitter is normally quiescent, and is switched on for periods of interrogation by remote control from the PPI console. An HT pulse transformer

in the transmitter may be connected so that the correct HT voltage (8kV) is applied to the oscillator valves from either of two types of modulator according to whether the transmitter is used in a mobile or a static station. In a mobile station, pulsed HT is derived from the primary radar modulator; in a static station, such as the present instance, it is derived from a separate IFF modulator, modulator Type 239 (*para. 33*).

3. Provision is made for both local and remote control, and for comparative measurements of RF power output on a built-in meter.

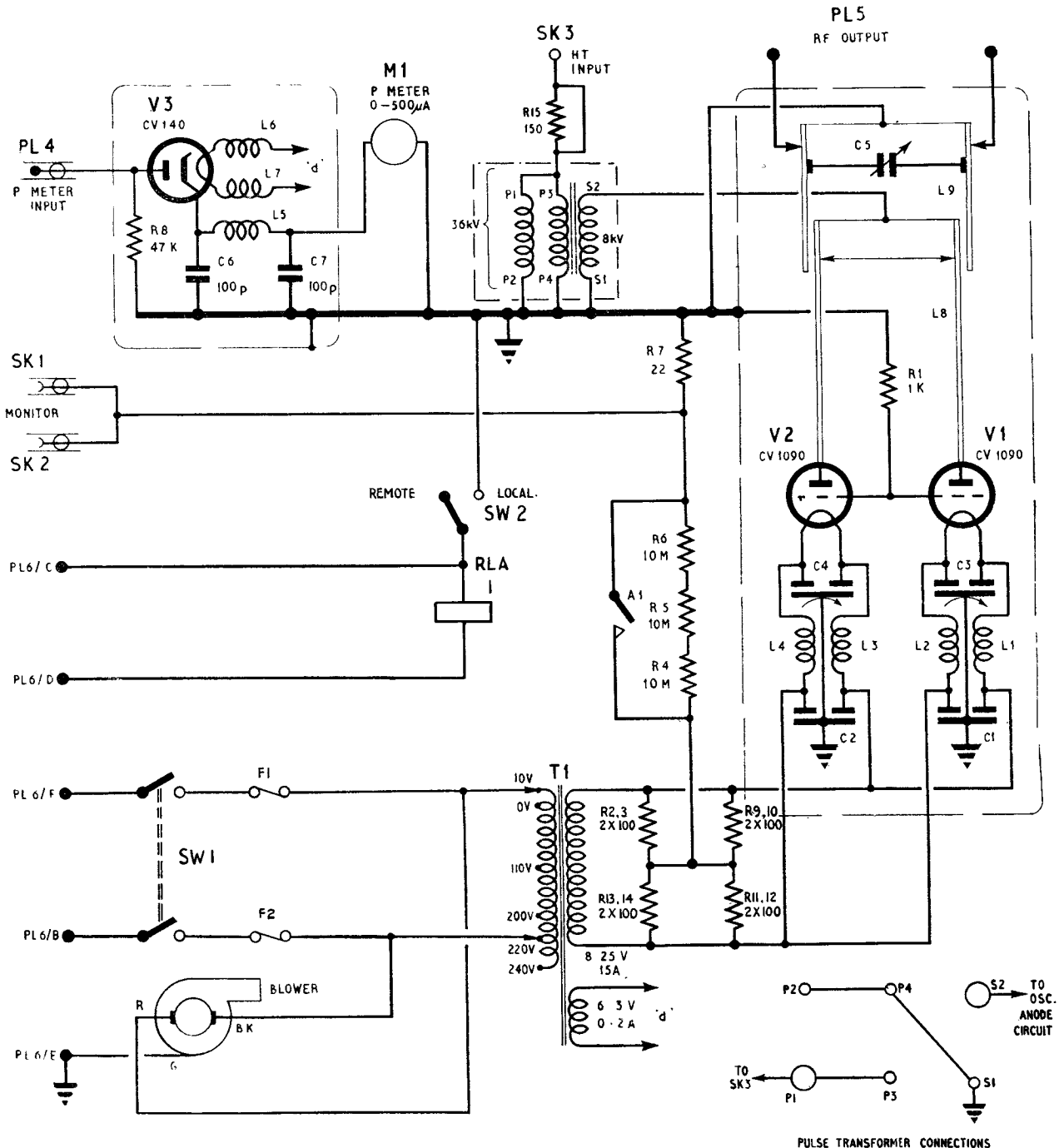


Fig. 2. Transmitter Type T.3686—circuit

4. The transmitter is designed to operate from a 110V, or 200 to 250V, 45 to 65 c/s single-phase supply. An additional 50V DC supply is required to operate the remote control relay.

CIRCUIT DESCRIPTION

5. When reading the following description, reference should be made to the circuit of the transmitter shown in fig. 2.

RF oscillator

6. The triode valves V1 and V2 function as a push-pull grounded-grid oscillator. The anodes of the valves are connected to a resonant line, L8; the electrical length of the line, and hence the frequency of oscillation, is determined by an adjustable shorting bar.

7. The filaments of the valves are directly heated and are operated at an RF potential above earth. The filament circuit of V1 is tuned by the inductors L1 and L2, which are in series with the filament supply leads, in conjunction with the preset capacitor C3. C1 functions as an RF by-pass across the filament supply. The filament circuit of V2 is similar to that of V1 the inductors L3 and L4 being tuned by C4, with C2 acting as an RF by-pass. The grids of the oscillator valves are connected together and earthed through the grid resistor R1.

8. The RF output line L9 is inductively coupled to the oscillator anode circuit. L9 is an earthed balanced line, and is tuned by C5; adjustment of C5 varies its effective electrical length.

9. Coupling between the output line and the RF output plug PL5 is through a balanced feeder. The feeder is tapped on to the output circuit at points that represent an impedance of 93 ohms.

Output monitor

10. The diode valve V3 functions as an RF rectifier and in conjunction with the micro-ammeter M1 (P METER) forms a peak reading valve voltmeter. The meter gives a comparative indication of the RF power output of the transmitter. RF pick-up is provided by a monitor aerial rod (aerial rod Type 345) fitted to the radar Type 79 aerial array. The monitor aerial is connected through a feeder to PL4 (P METER INPUT). RF voltage across the load resistor R8 is applied between the anode of V3 and earth. An RF filter consisting of the inductor L5 and capacitors C6, C7, is connected between the cathode of V3 and the meter, which measures the DC current flowing in the diode circuit. An RF filter consisting of L6 and L7 is connected in the heater supply leads to V3.

Power supplies

11. AC mains are applied to pins B and F of the plug PL6, thence through mains switch SW1 and fuses F1, F2 to the primary of transformer T1 and to the shaded-pole blower motor. Filament voltage for V1 and V2 is supplied by a low-tension secondary winding on T1. A second LT winding supplies heater voltage to the monitor diode.

12. Pulsed HT, derived from an external modulator, is applied via the socket SK3 to the primary of the pulse transformer T2. T2 reverses and steps up the voltage of the negative-going pulse from the modulator.

13. The primary of T2 is wound in two separate halves, which may be connected either in series or parallel. This arrangement is necessary to adjust the step-up ratio of the transformer so that an 8kV pulse is produced across the secondary when the transmitter is used in either mobile or static installations.

14. In mobile installations a 6kV pulse is applied to the transformer primary, and the two sections are connected in series. When the transmitter is used in static installations (as in the present application) a 3.5kV pulse is supplied by modulator Type 239 and the two sections of the primary are connected in parallel to provide a higher step-up ratio between primary and secondary; R15 is short-circuited. The physical connections are shown in the inset circuit to fig. 2.

15. In each instance the sense of the primary and secondary is such that terminal S2 is positive with reference to earth. The positive pulse is applied to the anodes of the oscillator valves via the parallel-line circuit L8.

Oscillator switching

16. Resistors, R2, R3, R9–R14, are connected in series-parallel across the transformer secondary supplying the filaments of the oscillator valves. The junction of the resistors forms an artificial centre-tap to the filament circuit; the artificial centre-tap is connected to earth through the resistors R4, R5, R6 and R7 in series. R4, R5 and R6 are of high resistance.

17. Relay RLA controls the transmitter switching. The normally-open contact RLA1 is connected across R4, R5 and R6. When RLA1 is open, R4, R5 and R6 are in series with the oscillator cathode circuit and earth. Due to the high resistance of R4, R5 and R6 (30 megohms), the voltage appearing between anode and cathode of the oscillator valves would be insufficient to cause oscillation even if an HT pulse should be applied between the anodes of the oscillator valves and earth.

18. When contact A1 closes, R4, R5 and R6 are short-circuited. The total pulse voltage will now be developed between anode and cathode of V1 and V2, which will oscillate. When the transmitter is driven from a modulator Type 239 the HT pulse is only applied when the G-band IFF key is closed (*para. 76*).

Relay control circuit

19. Local or remote control facilities are selected by the switch SW2. The 50V relay supply voltage, one side of which is earthed, is applied to PL6/D. When SW2 is set to LOCAL the coil of RLA and, in modulator Type 239, RL3 are connected between the 50V supply line and earth, and RLA and relay RL3 operates.

20. When SW2 is set to REMOTE, the relay operating line is disconnected from earth. This line is connected to PL6/C to the junction box in the IFF rack to the modulator Type 239 (*para. 76*) and via the cabin cableform, station wiring, etc., to the G-band IFF key on the radar console.

Monitor pulse

21. The pulse voltage developed across R7 due to cathode current when V1 and V2 are conducting is applied to the sockets SK1 and SK2 (MONITOR) which are connected in parallel. These sockets enable the pulse shape to be observed on the monitor Type 61. SK1 supplies a pulse for waveform observation while SK2 supplies a similar pulse for monitor time base synchronization.

CONSTRUCTIONAL DETAILS

22. The transmitter (*fig. 1*) is housed in a dust cover and fitted in a shock-absorbing mounting tray. The unit may be removed from the tray after loosening the two swivelling screws attached to the front of the tray; the dust cover may be removed after loosening a similar screw at each side of the unit. The dimensions of the transmitter are 18 in. wide $\times$ 20 in. deep $\times$ 12 in. high; the approximate weight is 20 lb.

23. No ventilating holes are provided in the dust cover; when the transmitter is operating the oscillator valves are cooled by a forced air system (*para. 28*).

24. The front panel of the transmitter is fitted with two detachable plates covering apertures

which allow access to the interior of the unit. An insulated tuning tool for tuning the output coupled circuit is normally housed in a clip fixed to the panel. The oscillator filament circuit tuning capacitors (FILS. TUNE) are accessible for adjustment from the front of the unit; each capacitor is adjusted through a hole in the circular plate covering the filament tuning assembly (*para. 31*).

25. In addition, the front panel carries the RF monitor, output meter (P METER), mains fuses and mains ON-OFF switch, REMOTE LOCAL switch and the following plugs and sockets:—

- (1) 6-pole Mk. IV MAINS INPUT plug (PL6).
- (2) Two coaxial MONITOR sockets (SK1 & 2).
- (3) Coaxial P METER INPUT plug (PL4).
- (4) RF OUTPUT plug (PL5).
- (5) HT INPUT socket (SK3).

26. The transmitter is divided internally into two sections:—

(1) Right-hand shielded section containing the RF oscillator.

(2) Left-hand section containing power supply components, remote control relay, blower motor and RF monitor.

27. Fig. 3 shows an interior view of the transmitter, with the top shielding plate removed from the oscillator sections.

28. The anode line is constructed of silver-plated copper tubes connected to the valve anodes by clips which fit round the anode cooling fins. The circuit is tuned to resonance by an adjustable shorting bar. The rear end of the anode lines is supported by the hollow blower box. When the transmitter is operating air is forced from the blower through a vulcanized rubber tube to the blower box, along the anode lines and past the anode cooling fins of each valve.

29. The output coupling line is also constructed of silver-plated copper tubing. The output line is connected to the OUTPUT plug PL5 through a short 95-ohm balanced binocular pair, formed by two 46-ohm coaxial cables the outer shielding of which is earthed; the inner conductors of the cables are connected to the coupling line through adjustable taps.

30. The coupling line is tuned by the parallel-plate capacitor C1; the capacitor is adjusted by the tuning tool through holes in the oscillator shielding box and the side of the dust cover. The low-potential end of the line is earthed through two silver-plated flexible strips. The degree of coupling between the anode and coupling lines may be varied by a screw

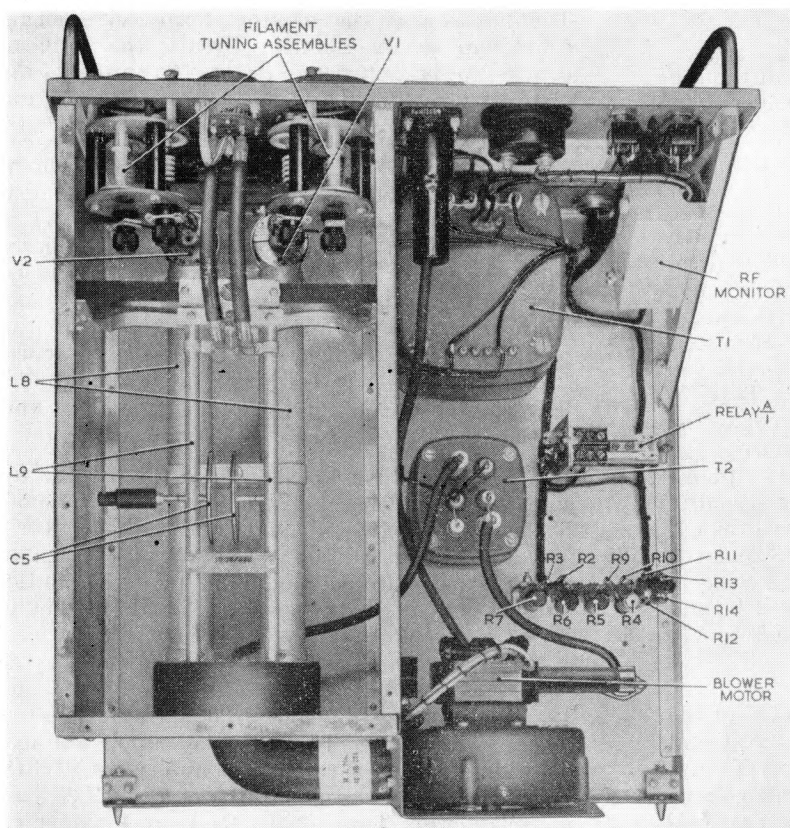


Fig. 3. Transmitter Type T.3686—interior view

located in the centre of the insulated bar mounted immediately in front of the line; adjustment of the screw raises or lowers the end of the coupling line.

31. The filament tuning and by-pass components of each oscillator valve are mounted in an assembly consisting of two silver-plated brass discs, separated by insulating spacers; these discs form one plate of the filament circuit capacitors. The other plate of each fixed capacitor is formed by a brass disc

insulated from the larger disc by sheet mica. The four fixed capacitors so formed are connected one at each end of the two filament inductors, which are located between the two larger discs.

32. The preset filament tuning capacitor of each valve is formed by the capacitance between the rear brass disc of each assembly and a small circular plate; these capacitors are adjustable from the front panel (*para.* 24).

MODULATOR TYPE 239

33. Modulator Type 239 (Stores Ref. 10D/18598) is used in conjunction with transmitter T.3686 in IFF Mk. 3G static installations. The unit is operated from an external triggering pulse and delivers pulsed HT voltage to the IFF transmitter.

34. The modulator is capable of being triggered by positive pulses having an amplitude of not less than 7.5V and a duration of $5\mu\text{s}$. The peak power output is 50kW in $2\mu\text{s}$ pulses when working into the optimum resistive load of 215 ohms. The leading edge of the output pulse is delayed by approximately $40\mu\text{s}$ on the commencement of the triggering pulse.

35. The unit will operate from input pulses having a repetition frequency of 250 to 500 and 500 to 800 p.p.s., and delivers output pulses from 250 to 400 p.p.s. When operated from pulses in the higher range, a frequency halving circuit is switched

into operation; this ensures that the repetition frequency of the output pulses is always between 250 and 400 p.p.s.

36. The modulator operates from a 230V, 50 c/s single-phase mains supply.

CIRCUIT DESCRIPTION

37. When reading the following description reference should be made to the circuit diagram on fig. 11, and the voltage and current waveforms on fig. 12.

38. Positive triggering pulse at SK3 are applied to the grid of V1A via C1 and a grid stopper R1A. DC restoration of the input pulses after C1 is effected by the diode valve V3b, which is connected across the grid resistor R1.

Pulse-forming stage

39. V1a and V1b are two sections of a double-triode valve operating in a cathode-coupled flip-flop circuit, which functions as a pulse forming stage. In the absence of a triggering pulse the circuit is quiescent, V1a is in a condition near cut-off, the valve being biased by the voltage developed across the cathode resistor R2. V1b is conducting fully, the effective grid voltage for this section is zero as the grid of V1b is returned to the slider of R6 through grid leak R7 and R6 is connected in series with R27 across the HT supply.

40. When a positive triggering pulse is applied to the grid of V1a the anode current increases for the duration of the pulse. This causes a drop in anode voltage, the negative-going step developed across R3 having an amplitude of approximately 120V. This step is applied to the grid of V1b via C3, cutting off V1b and resulting in a positive-going step with an amplitude of approximately 125V being developed across the anode load R4 of V1b.

41. The negative voltage on the grid of V1b leaks away as C3 charges and after a certain

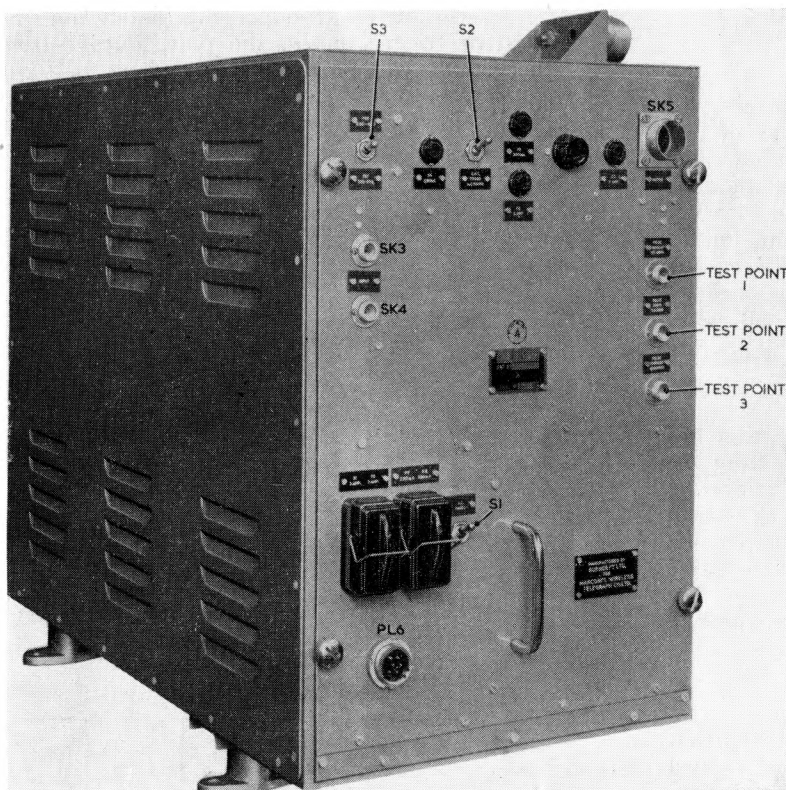


Fig. 4. Modulator Type 239

pulse the pulse forming network will charge up from the EHT supply; provided that the recurrence period of the modulator is less than half the period of the resonant circuit formed by L2 and the total capacitance of the pulse forming network the network will charge to a potential approximately twice that of the EHT.

62. The cathode of the trigatron is connected via SK5 to the external load which consists of the primary of the EHT pulse transformer T2 in transmitter Type T.3686.

63. The first half-cycle of the damped oscillations in the anode circuit of V6 fire the trigatron. This pulse has an amplitude of +3.5kV when the trigatron is in circuit; any subsequent oscillation is quenched when the trigatron fires. The pulse forming network discharges through the trigatron and the primary of the transmitter pulse transformer in series. The current pulse through V7 and the external load is maintained for a period dependent on the values of inductance and capacitance forming the pulse forming network, and has a duration of approximately 2 μ s.

64. The negative voltage pulse across the primary of the transmitter pulse transformer has an amplitude of 3.5kV. The pulse is substantially rectangular if the load presented by the transformer primary is non-reactive and presents a resistance, which is equal to the characteristic impedance of the pulse forming network (215 ohms).

65. The parallel-connected resistors R55 and R56, by-passed by C17, are in series with the pulse forming network and earth. This enables the waveform of the pulse discharge current to be monitored on an oscilloscope connected between test point 1 and earth.

Power supplies

66. HT, LT and bias supplies are derived from the mains transformer TR1. The HT voltage is obtained from a centre-tapped secondary winding in conjunction with the full-wave rectifier V11. The DC output of the rectifier is connected via the fuse FS7 in the positive lead to a smoothing filter consisting of the reservoir capacitor C24, choke L1 and smoothing capacitor C20. A discharge resistor R68 is connected across the smoothed DC supply.

67. The AC voltage across one-half of the HT secondary is applied to the cathode of a half-wave rectifier V10, consisting of a double-diode with its electrodes strapped to form a single diode. The anode, which is negative with respect to earth, is connected via a fuse FS8 and limiting resistor R73 to the reservoir capacitor C23. The DC voltage across C23 is smoothed by R72, in series with the winding of relay RL6 and C22; a discharge resistor R71 is connected across C22. The output is stabilized at 150V by the cold-cathode voltage stabilizer V9, the priming electrode of which is connected via R70 to the positive pole of the supply (earth).

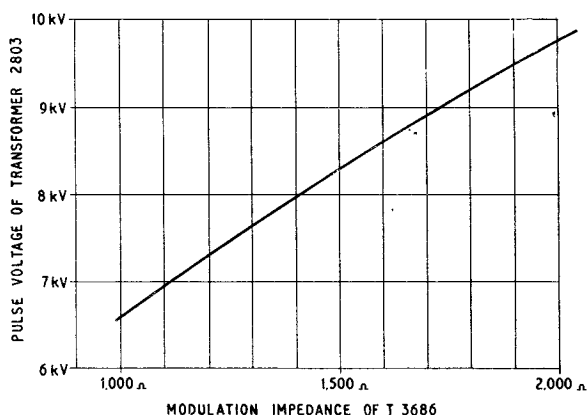


Fig. 7. Transmitter HT voltage

68. The earth return circuits of both HT and bias supplies are completed through a resistor R69, connected in series with the common lines. The contact RL6/1 and a by-pass capacitor C21 are connected in parallel with R69, RL6/1 being closed during normal operation.

69. R69 is a safety resistor which ensures that the modulator is protected should a fault occur on the bias supply. If the stabilizer fails to strike, a negative bias greater than 150V will be applied to the valves, and the modulator will be rendered inoperative. Should the bias supply from V10 fail, the stabilizer will not strike and relay RL6 will not operate. Then the total cathode current of the modulator valves will flow through R69 and a high potential will be developed across it. The voltage of the HT supply will thus be reduced by the voltage developed across the resistor, resulting in the anode voltage being reduced to a safe value.

70. EHT supply for the pulse forming network is derived from the mains transformer TR3 and half-wave rectifier V8; heater voltage for V8 is obtained from a separate mains transformer TR2. The DC output of the rectifier, which is negative with respect to earth, is smoothed by R57 and C18. R58 to R66 are discharge resistors connected across C18.

71. The positive pole of the EHT supply is connected to earth through the coil of the overload relay RL4/1 in parallel with R67 and C19.

Mains supply and overload circuits

72. The operation of the mains supply and overload circuits is best understood by considering the sequence of events that occurs when the modulator is switched on.

Mains supply circuits

73. When the double-pole switch S1 (AC MAINS) is closed, the mains are applied from PL6/A and PL6/F via the fuses FS1, FS2 and contacts of S1 to the primary of the mains transformer TR1; this supplies LT, HT and bias voltages. After the heater of the bias rectifier V10 has warmed up, the stabilizer V9 strikes from the bias supply and relay RL6 operates; contacts RL6/1 close and short-circuit R69; normal HT and bias voltages are now applied to valves V1 to V6, and V12.

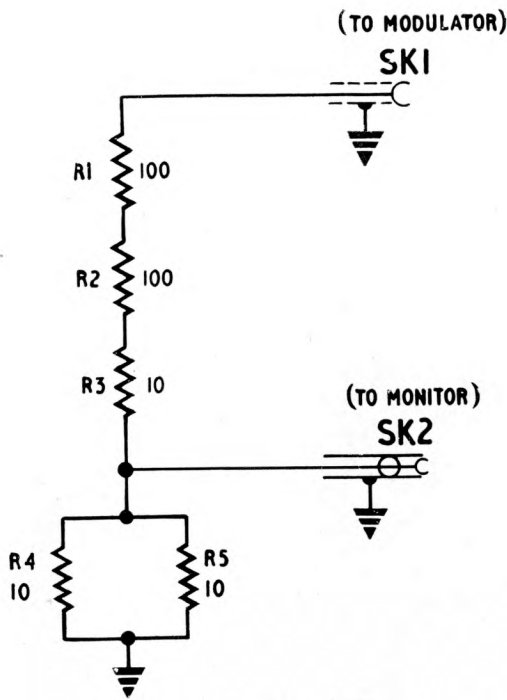


Fig. 8. Dummy load 36—circuit

74. The mains supply is also extended via the fuses FS3, FS4 to the primary of TR2. This supplies the heater of the EHT rectifier V8.

EHT rectifier V8

75. The thermal relay RL1 is connected across the 6.3V heater supply via the normally made

contact, RL2/2, in series with the parallel-connected resistors R82 and R83. Approximately one minute after switching on, RL1 operates. Contact RL1 closes and completes via R81. The normally-open contact RL2/1, connects in parallel with RL1, closes and holds relay RL2. Contact RL2/2 opens and disconnects RL1, which releases; contact RL2/3 closes and prepares a circuit for relay RL3.

76. S2 (EHT TRANS) is now closed, and the circuit for the mains supply to the primary of the EHT transformer is now completed, except for RL3/1. Assume that the G BAND IFF key on the display console is closed, that is, PL6/C on the modulator is earthed. Relay RL3 is now energized from the 50V DC supply through the contact RL2/3. Contact RL3/1 closes and mains are applied via fuses FS5, FS6, contacts of S2, microswitch S4, contact RL3/1 and RL5/3 to the primary of TR3; the EHT supply is now available.

77. Should the 380V HT supply fail, relay RL2 will release and contact RL2/3 will open the circuit of relay RL3 and contact RL3/1 will open-circuit the mains supply to TR3.

EHT overload circuit

78. The EHT overload circuit is incorporated to prevent damage to the EHT power supply should the trigatron 'hold on' and pass current after the normal pulse.

79. When S1 is closed, LT, HT and bias voltages are applied to the pentode V12. Approximately 50V negative bias is applied to the grid of V12, via

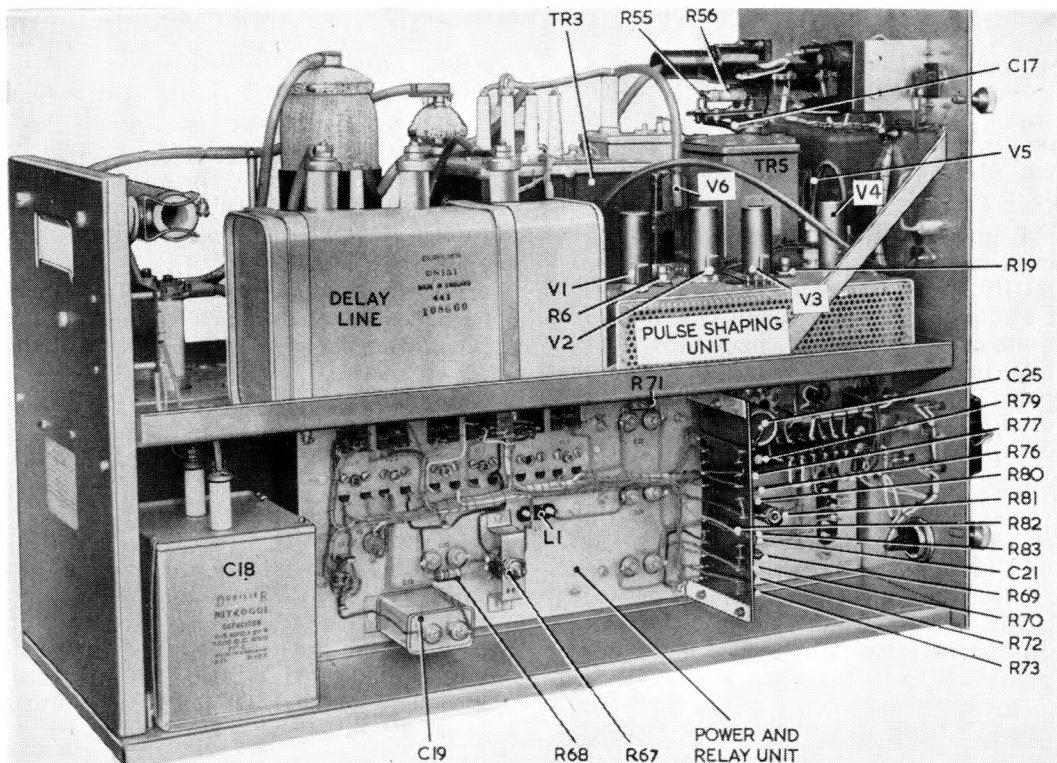


Fig. 9. Modulator Type 239—left-hand side view

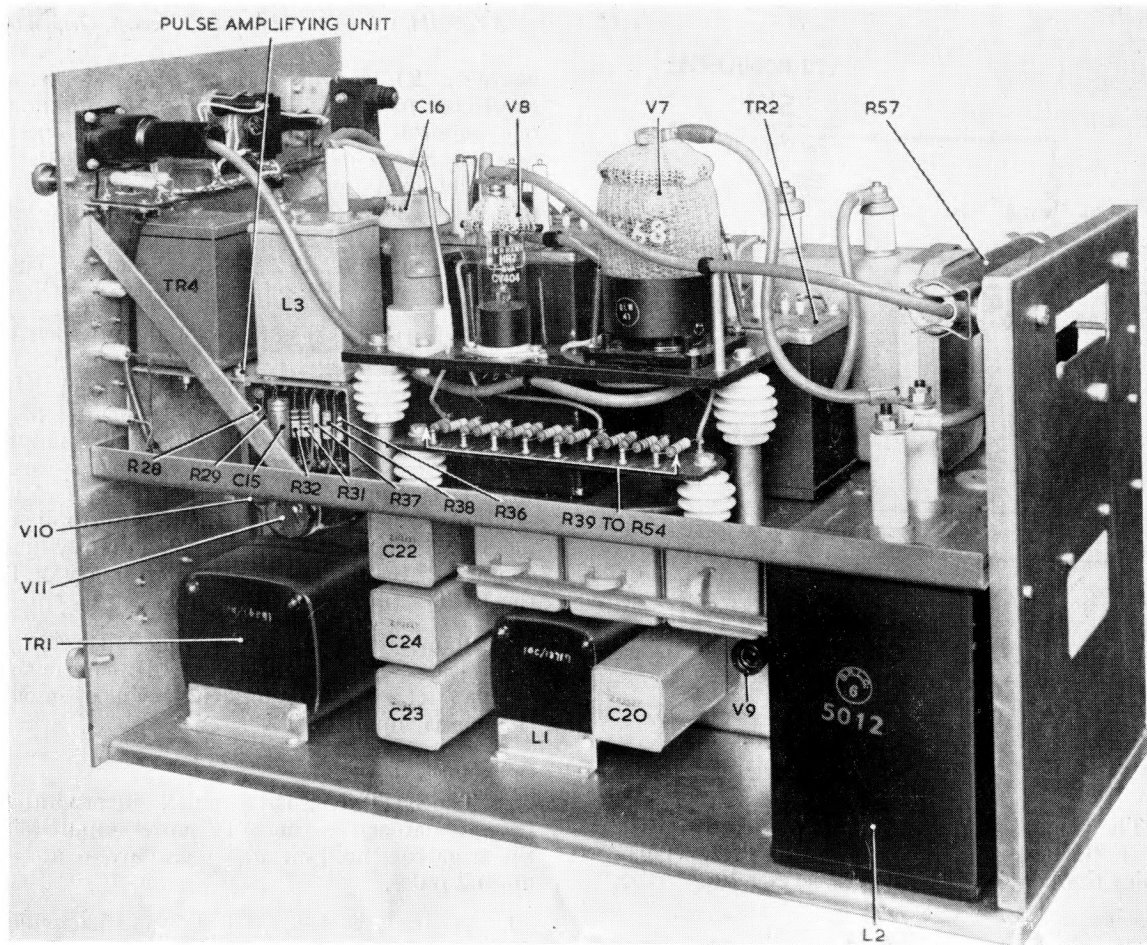


Fig. 10. Modulator Type 239—right-hand side view

the stopper resistor R78 from the junction of R76 and R77 which are connected across the 150V negative supply. This biases V12 to cut-off, and relay RL5, connected in series with R80 in the anode circuit of the valve, does not operate.

80. Should an overload occur, the increase in current from the EHT supply operates RL4. Contact RL4/1 opens and removes the negative bias from V12 grid. V12 now conducts and RL5 operates. Contact RL5/1 and 2 change over and connect C25 between anode and grid; contact RL5/3 opens the primary circuit of TR3 and removes the EHT supply.

81. Simultaneously, C25 commences to charge negatively and, after a period of approximately 30 seconds, the resultant negative charge on the grid cuts off V12 again. RL5 releases, and provided that the overload does not recur, the circuit returns to normal. R79, connected across C25, when RL5 is unoperated, ensures that the capacitor is discharged.

Test points

82. Three test points are provided for connection to a CRT monitor, for waveform monitoring the

pulse current in the circuits connected to test points 1 and 3 can be determined as follows:—

(1) **PULSE CURRENT V/5 AMPS.** The monitor measures the voltage across the parallel-connected resistors R55 and R56 in series with the pulse-forming network. The pulse current flowing through the pulse-forming network is equal to the voltage divided by 5.

(2) **PULSE SHAPE V6 GRID.** The monitor gives an indication of the shape of the pulse applied to the grid of V6, and a measurement of the voltage across R36.

(3) **PULSE CURRENT V/50 AMPS.** In this instance the monitor indicates the shape of the anode current pulse of V6. Actual current is equal to the pulse voltage divided by 50.

Transmitter HT voltage

83. Fig. 7 consists of a graph showing the relationship between HT voltage and modulation impedance of a transmitter T.3686 when pulsed at a p.r.f. of 400 from a modulator Type 239. The voltage indicated is that developed across the secondary of the HT pulse transformer in the transmitter.

84. The transmitter and modulator are correctly matched when the transmitter presents a load of

1400 ohms. The actual modulation impedance varies from 1200 to 1800 ohms, but within these limits the loss in power is negligible.

Modulator dummy load

85. Dummy load Type 36 (Stores Ref. 10S/16195) is a $2\mu\text{s}$ modulator load suitable for checking the output of modulator Type 239. The load has an impedance of 215 ohms and is rated for a peak power of 3.2kV at 15A and a mean power of 38 watts. Each dummy load is calibrated to an accuracy of 1 per cent.

86. The circuit of the load is shown in fig. 8. The output socket (SK5) of the modulator is connected to SK1 on the dummy load using a connector No. 7423 (Stores Ref. 10HA/5248). A portion of the modulator output voltage is developed across the parallel-connected resistors R4 and R5 and applied via SK2 to the input of the IFF monitor (monitor Type 61).

CONSTRUCTIONAL DETAILS

87. The modulator (*fig. 4*) is housed in a ventilated steel case measuring $19\frac{1}{2}$ in. high $\times$ $13\frac{1}{2}$ in. wide $\times$ 24 in. deep and weighs approximately 140 lb. The front panel and chassis may be removed from the case after loosening the four captive coin-slotted screws on the panel.

88. Fig. 9 and 10 show views of the chassis removed from the case. The component parts of the modulator are assembled on two decks, one above the other. The following items are mounted on the lower deck:—

(1) Relay and power unit. This consists of the low voltage power supply, relays and relay control circuits.

(2) EHT smoothing capacitor C18.

(3) Delay line charging choke L2.

89. The following items are mounted on the upper deck:—

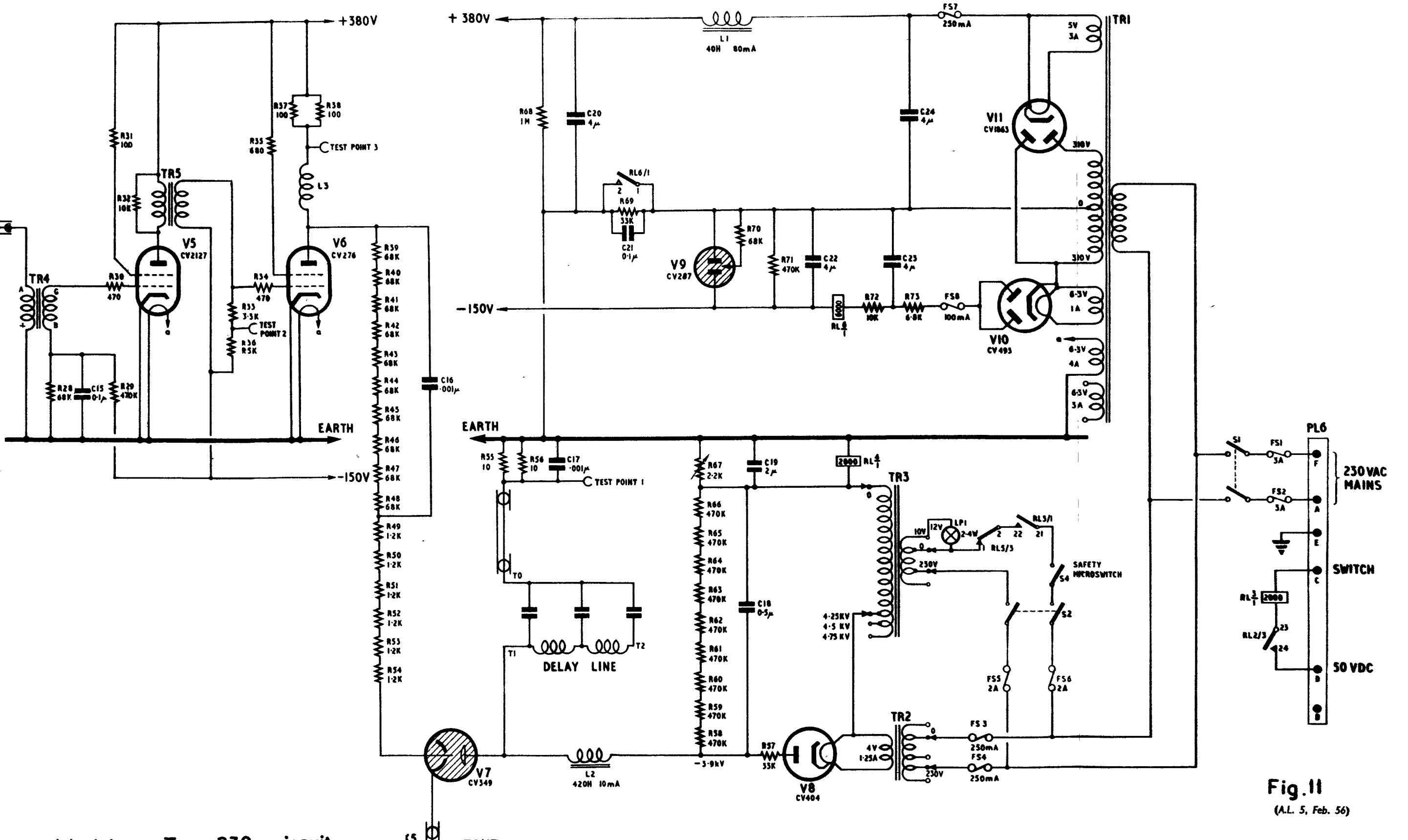
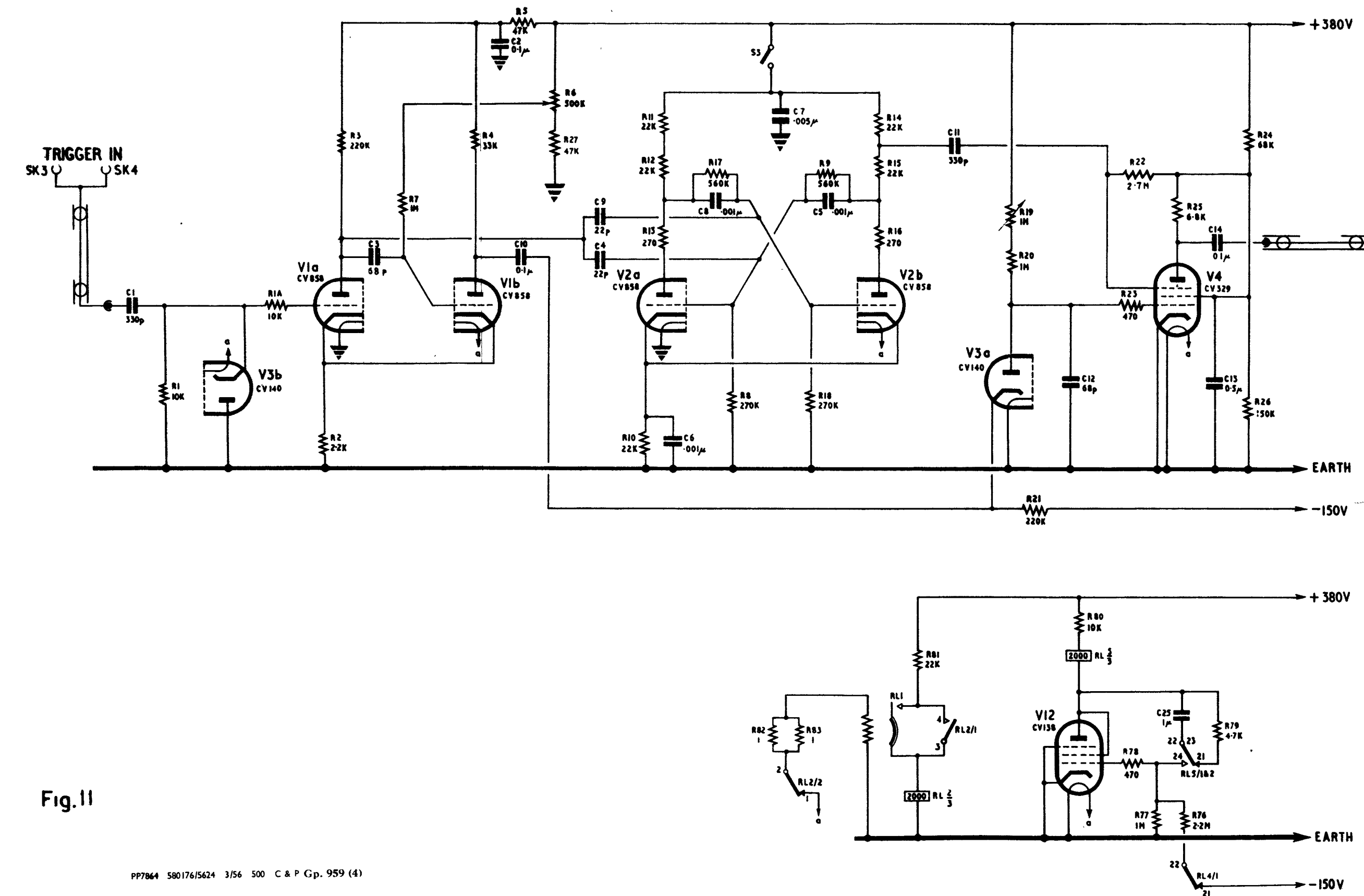
(1) Pulse shaping unit. This consists of the valves V1 to V4.

(2) Pulse amplifying unit. This consists of the valves V5 and V6.

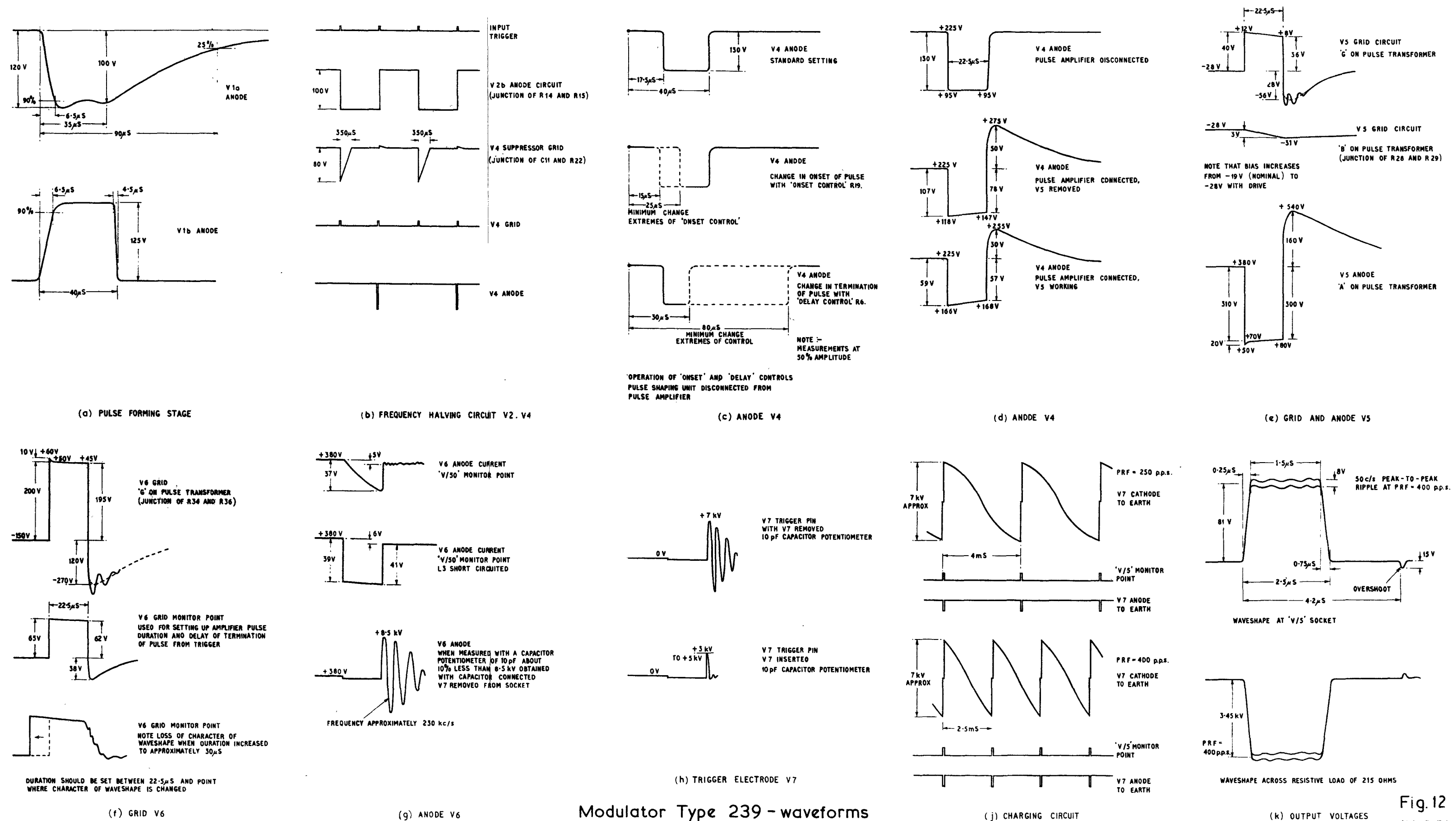
(3) Pulse forming network.

(4) EHT supply circuit, trigatron, and associated components.

90. The EHT bleeder chain, consisting of the resistors R58 to R66 is mounted on an insulated tag board on the rear plate of the modulator. The EHT series resistor R57 is mounted on stand-off insulators fixed to the rear plate.



Modulator Type 239 - circuit

Fig.12
(A.L. 5, Feb. 56)

Modulator Type 239 - waveforms

Chapter 3

RECEIVER TYPE R.3684 AND AMPLIFIER TYPE A.3687

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RECEIVER TYPE R.3684

General description

1. Receiver Type R.3684 (Stores Ref. 10D/18314) is a superheterodyne pulse receiver employed in mobile and static IFF Mk. 3G installations.

2. The receiver can be manually tuned to cover the IFF G-band. The aerial input circuit is untuned and has an impedance of 70 ohms, which is suitable for connection to the output of an amplifier Type A.3687 (para. 38).

3. The mean intermediate frequency of the receiver is 11.2 Mc/s. The IF stages have wide-band characteristics, obtained by staggered tuning; the response of the IF circuits is 6 dB down at an overall band-width of 4.0 Mc/s.

4. Both positive and negative-going pulses are available from the output. The gain of the receiver is remotely controlled from the radar 7 Mk. 3. Test points are provided which enable the cathode current of each valve to be monitored by an external meter; other test points permit a signal generator to be connected to the input of the IF amplifier for alignment.

5. The receiver contains an integral power unit which operates from a 110V, or 200 to 250V, 45 to 65 c/s single-phase supply.

Constructional details

6. The receiver measures $10\frac{1}{4}$ in. wide $\times$ $8\frac{5}{16}$ in. high $\times$ $19\frac{5}{8}$ in. deep and weighs approximately 40 lb. It is fitted in a shock absorbing mounting tray which may be detached after disengaging two swivelling screws from lugs at the front of the unit. The chassis and panel may be withdrawn from the dust cover after loosening a swivelling screw at each side of the front panel. The top half of the panel is protected by a spring-loaded hinged cover, which is secured by a catch.

7. Mains fuses, HT test points and tuning controls are accessible from the front panel. Two tuning controls permit adjustment of RF and local oscillator circuits. The control knobs are coupled through a flexible bellows drive and fibre couplings to the adjustable cores of the RF and oscillator inductors; the relative position of each core is indicated by a scale viewed through a small aperture in the panel. Stops are fitted to limit the travel of the control knobs in each direction.

(A.L.4, Jan. 56)

8. The front panel also carries a double-pole mains switch (S1), a 6-pin Mk. 4 MAINS INPUT plug (PL6) and the following coaxial plugs and sockets:—

- (1) RF INPUT plug (PL5)
- (2) PULSE INPUT socket (SK1)
- (3) GAIN CONTROL socket (SK4)
- (4) OUTPUT + and OUTPUT — socket (SK2 and SK3).

RF sub-chassis

9. The RF stages, consisting of RF amplifier (V2), local oscillator (V3) and mixer valves (V4) are mounted on a sub-chassis located towards the front of the main chassis. The input plug (PL7) on the RF sub-chassis is connected to the RF INPUT plug on the front panel through a short length of 72-ohm coaxial cable.

10. The sub-chassis may be detached after removing the six screws securing it to the main chassis, and loosening the screws by which the flexible drives are attached to the fibre couplings. Electrical connections to the RF stage must be unsoldered; these connections are located beneath the removable plate on the right-hand side of the sub-chassis.

11. The IF stages (V5, V6, V7, V9 and V10) and the DC restorer (V8) are positioned at the right-hand side of the main chassis, to the rear of the RF sub-unit. Anode resistors, inter-stage coupling capacitors and decoupling components are contained in the screening cover housing the appropriate IF inductor. The two sockets (IF and E) connected to the input of the IF amplifier are mounted on the side drop of the chassis adjacent to the first IF stage.

12. The detector (V11), video amplifier (V12) and cathode-follower output stage (V13) are positioned at the rear of the chassis.

13. Power supply components, consisting of the mains transformer (T1), smoothing choke (L14) filter capacitors (C57, C58) and rectifier valve (V14) are located at the left-hand side of the chassis to the rear of the RF sub-chassis.

Circuit description

14. When reading the following circuit description reference should be made to the block diagram of the receiver shown in fig. 1 and the circuit diagram in fig. 10.

RF Stage

15. Signal voltage is applied via PL5 and PL7 to the untuned grid circuit of V2, a pentode valve functioning as RF amplifier. The resistor R79 connected between grid and earth, in parallel with the low input impedance of the valve at the frequencies being considered gives an effective input impedance of the receiver of approximately 70 ohms. Bias is derived from the cathode resistor R14.

Test points

16. HT supply to the anode and screen of V2 is via a metering resistor R11, decoupled by C7. A test point (x2) is connected through resistor R7 to the low potential end of R11; this enables a voltmeter to be connected between the test point and the positive HT line (x11) to measure, in effect, the voltage drop across R11 and to give an indication of the combined anode and screen current of V2. A similar method is used for monitoring the HT current to all amplifying stages of the receiver.

17. The screen grid of V2 is fed through R10, decoupled by C10. The anode load consists of the resistor R12 in parallel with the shunt-fed inductor L5, which is tuned to the signal frequency.

Local oscillator

18. The local oscillator employs a triode valve, V3, operating in a shunt-fed Colpitts circuit. HT is fed to the anode of the valve via R17, decoupled by C11. The variable inductor L4, and capacitor C12 are parallel fed via C15 from the anode of V3, and in conjunction with C17, C18, C21 and the inter-electrode capacitance of the valve, form the tuned oscillatory circuit. C16 and R15 function as oscillator grid capacitor and resistor; negative grid bias to maintain the optimum oscillatory condition is developed across R15, due to flow of grid current.

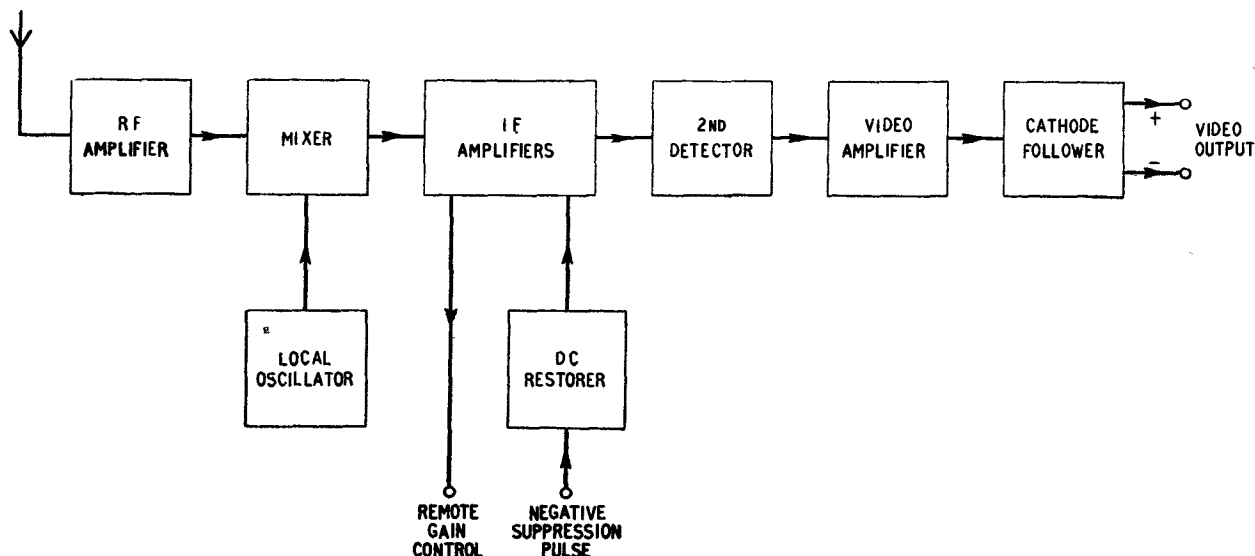


Fig. 1. Receiver Type R.3684—block diagram



Fig. 2. Receiver Type R.3684—front cover lifted

19. The oscillator works on a frequency lower than that of the incoming signal. Heterodyne voltage is fed via C17 to the mixer circuit.

Mixer

20. The diode V4 operates as a mixer. The output of the RF amplifier is fed to the anode of the diode from a tap on L5. Heterodyne voltage from the local oscillator is developed across R16, C18 and C21 in parallel and fed in series with the output of L5 to the mixer anode. Additive mixing takes place and IF output is developed across the mixer load,

consisting of L7, and C20 in parallel forming a resonant circuit and damped by R13. The tuned circuit is tuned to the intermediate frequency of 11.2 Mc/s, which is the difference between local oscillator and signal frequencies.

IF stages

21. The pentode valves V5, V6, V7, V9 and V10 function as IF amplifiers. The circuits associated with V5, V6 and V7 are identical. Considering V5, IF voltage developed across the tuned circuit in the cathode circuit of the mixer is applied directly to the

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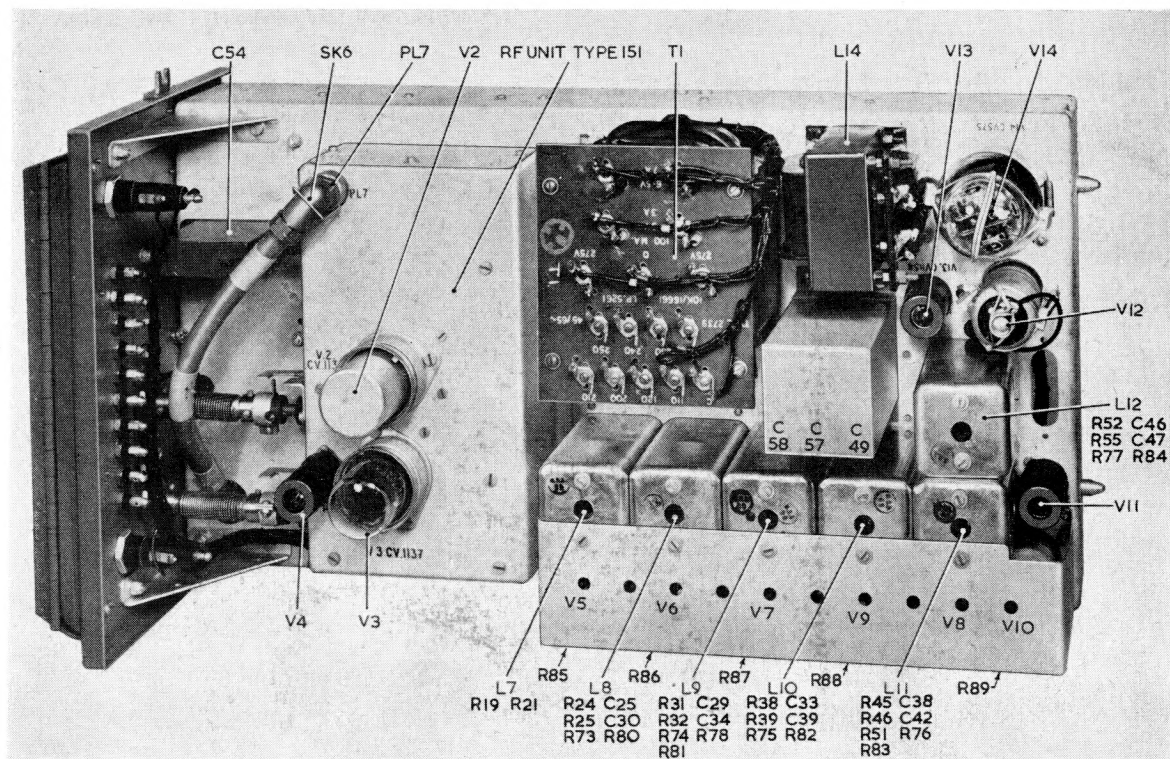


Fig. 3. Receiver Type R.3684—dust cover removed

grid of the first IF valve. The test point designated IF is connected to the grid of V5 via a resistor R21; this enables an IF signal to be injected into the IF amplifier.

22. HT anode and screen supply circuits are of conventional design. R26 functions as an anode stopper. The anode load consists of resistors R25 and R73 in parallel, in conjunction with the IF

tuned circuit L8, which is shunt-fed from the anode of V5 through C30.

23. The cathodes of V5, V6 and V7 are connected through resistors R27, R34 and R41 respectively to a common gain control line terminated by a socket SK4 (GAIN CONTROL). This enables the gain to be controlled externally by a variable resistor connected to SK4. The resistors R71, R72 by-

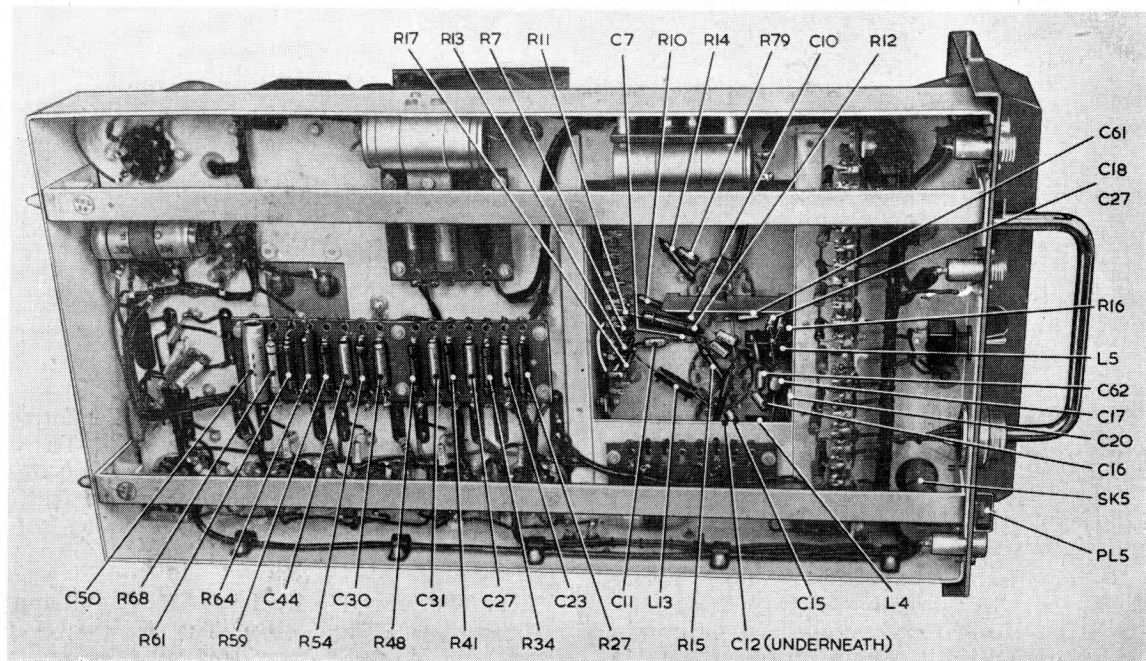


Fig. 4. Receiver Type R.3684—under-chassis view (1)

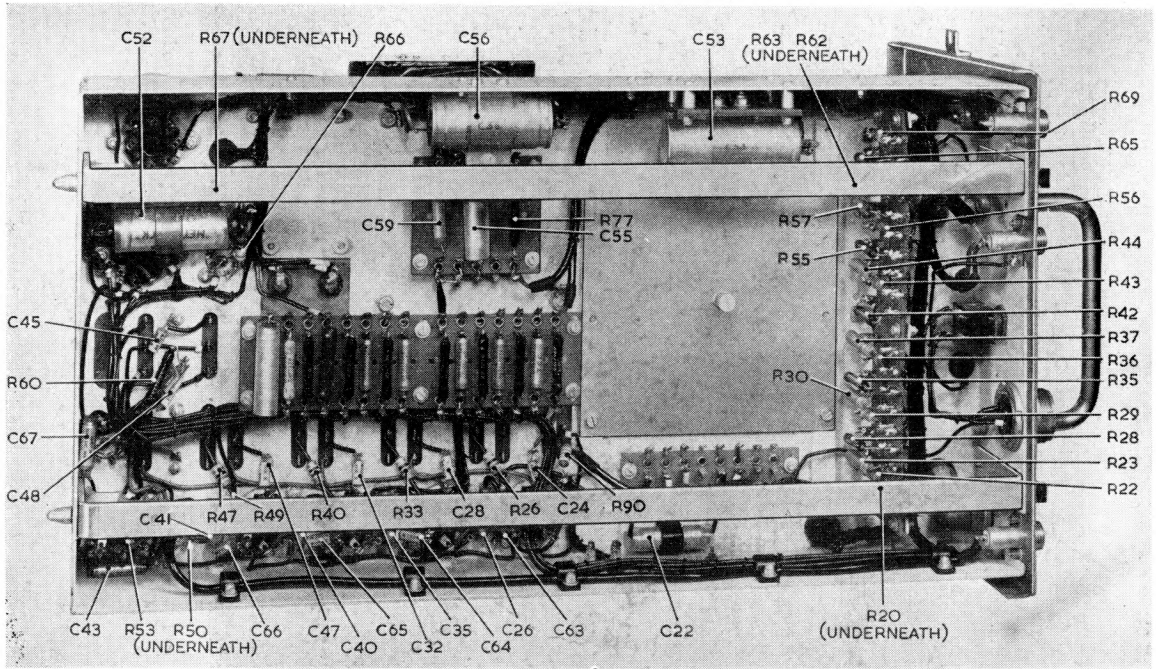


Fig. 5. Receiver Type R.3684—under-chassis view (2)

passed by C55 and C56 and connected between the gain control line and earth and HT prevents the cathodes of the controlled valves from being disconnected when the external control is not plugged in, and give a more linear variation of gain with rotation of the external control.

DC restorer

24. The suppressor grid of V9 is connected via R49 to SK1 (PULSE INPUT) and the anode of the diode V8; the diode and the resistor R50 are connected between SK1 and earth. This enables the receiver to be cut off by a negative-going pulse applied as bias to the suppressor grid via SK1. When the suppression pulse is AC-coupled DC restoration is effected by the diode in conjunction with R50. When DC coupling is used the diode is inoperative.

25. The cathodes of V9 and V10 are returned to earth through the bias resistors R48 and R54, bypassed by C41 and C43. The anode and screen circuits of V9 and V10 are identical with those of the three previous IF stages.

Detector

26. The anode of the final IF valve V10 is connected via C47 to the inductor L12; the IF voltage developed across the inductor is applied to the cathode of V11, a diode valve functioning as detector. Output from the anode of V11, in the form of

negative-going pulses, is developed across the diode load R60. C48 is a by-pass to earth for residual IF voltage in the output circuit of the detector.

Video amplifier

27. The negative-going pulses appearing across the diode load are fed via a grid stopper R59 to the grid of the video amplifier V12. Bias is derived from the cathode resistor R61. Anode circuit decoupling is by R63, in conjunction with C49 and

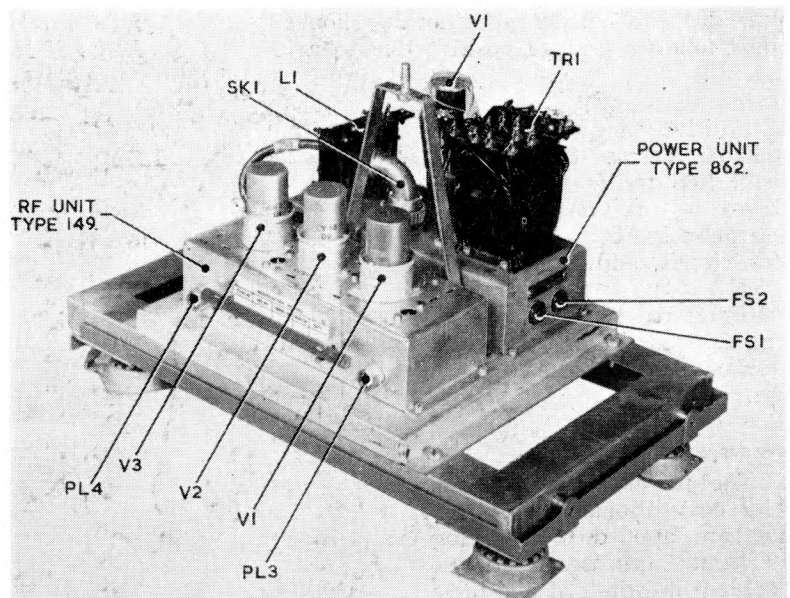


Fig. 6. Amplifier Type A.3687—dust cover removed

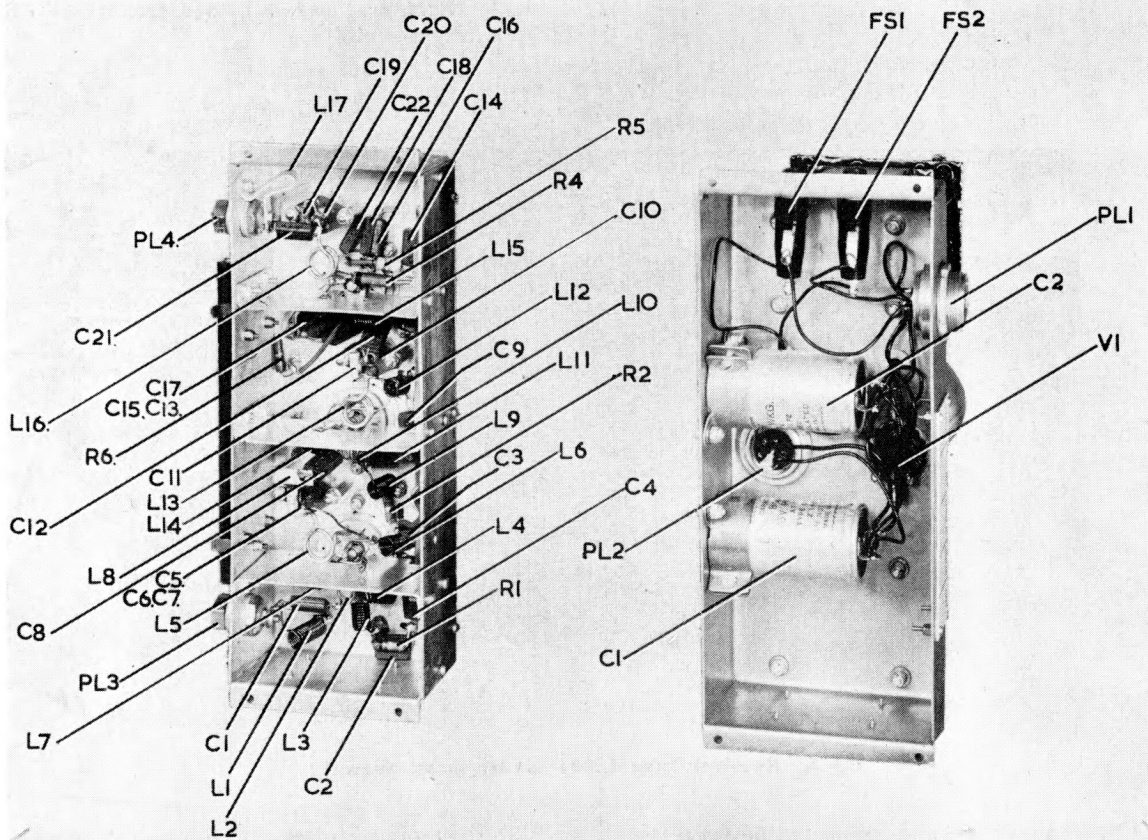


Fig. 7. RF unit Type 149 and power unit Type 862 under-chassis view

C50 connected in parallel. R64 forms the anode load of the video amplifier.

Cathode-follower

28. The electrodes of the double-triode valve V13 are strapped to form a single triode, which functions as a cathode-follower output stage. Positive-going pulses from the anode of V12 are fed via C52 and a grid limiter R66 to the grid of V13. R66 prevents appreciable grid current from flowing should the cathode-follower grid go positive due to a large pulse.

29. Positive-going pulses are developed across the cathode resistor R68 and are fed to SK2 (OUTPUT +) via C53. Negative-going pulse are derived from the anode circuit, and fed via C54 to SK3 (OUTPUT -). The monitoring resistor R69 acts as an anode load and R70 provides an output load for the negative pulse circuit.

Power supplies

30. The power supply circuits are of conventional design. AC mains are applied to the plug PL6 (MAINS INPUT) and fed via a double-pole switch S1 and fuses F1, F2 to the primary of the mains transformer T1.

31. HT is derived from a centre-tapped high-voltage secondary on T1, in conjunction with a full-wave rectifier valve, V14. C58 functions as a reservoir capacitor, and is followed by a single-section smoothing filter consisting of L14 and C57.

Note . . .

The centre tap of the HT secondary winding is not earthed, but brought out to pin D on the mains plug PL6 to allow for remote switching as in the radio Radar 15 Mk. 5 IFF installation. When used in the

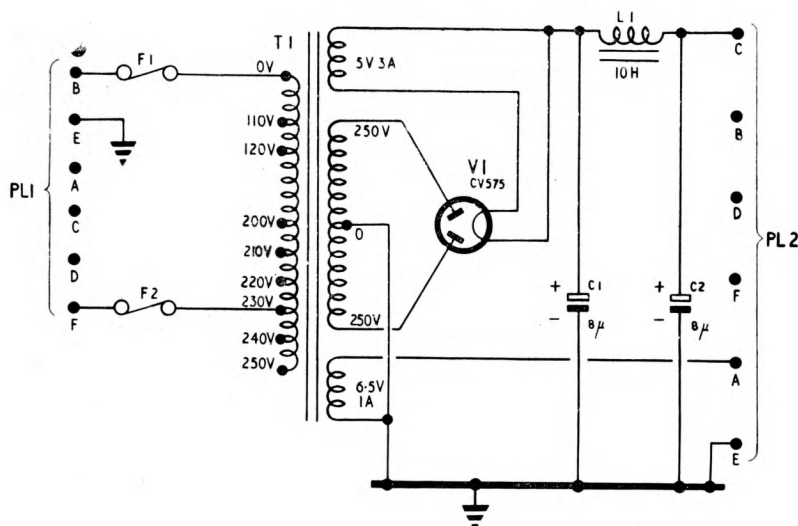


Fig. 8. Power unit Type 862—circuit

radar 79 there is a connection between points D and E of the cable mounted socket which plugs into PL6, which earths the centre tap.

32. Heater supplies are obtained from a low voltage secondary winding, which is by-passed to RF by C59. The heater wiring to the RF stages is screened, and the heaters of V2, V3 and V4 are by-passed to earth. The heaters of the IF amplifiers V5, V6, V7, V9 and the detector V11 are also by-passed to earth.

Gain control for bench testing

33. An external gain control must be provided for bench testing the receiver; the control should consist of a 3,000-ohm reversed log-law potentiometer connected to give zero resistance when turned fully clockwise. A linear-law potentiometer may be used, but this will result in the control being cramped at one end of the scale.

Test voltages

34. The limits of the voltage between the positive test point (x11) and each of the remaining test points (x2 to x10) measured on a testmeter Type D set to the 12V DC range are given in Table 1 below.

35. The voltage measured between test point x11 and earth should be within the limits 260V to 320V, with the testmeter set to 480V DC.

36. The figures quoted are for conditions of no signal input to the receiver and with the gain control (connected externally) set at maximum, except where otherwise stated.

TABLE 1
Receiver Type R.3684—test point voltages

Test point	Voltage	Remarks
x2	1.0–1.6	
x3	4.0–6.0	
x4, x5, x6, x7 and x8	1.6–2.4	
x9	4.0–6.0	gain at minimum
x10	0.4–0.6	

37. Voltages at the electrodes of the valves measured by a testmeter Type D connected between the valves electrode and earth are given in Table 2. Anode and screen voltages are measured with the testmeter set to the 1200V DC range. Cathode voltages are measured with the meter set to the 12V DC range.

TABLE 2
Receiver Type R.3684—valve electrode voltages

Valve	Anode V	Screen V (Tolerance = 30%)	Cathode V
V2	230	240	2.0
V3	200	—	0
V5	150	210	1.6
V6	150	210	1.6
V7	150	210	1.6
V9	150	210	1.6
V10	150	210	1.6
V12	90	190	0.9
V13	290	—	6.2

AMPLIFIER TYPE A.3687

GENERAL DESCRIPTION

38. Amplifier Type A.3687 (Stores Ref. 10U/16030) is an RF pre-amplifier used in conjunction with receiver Type R.3684 in mobile and static IFF Mk. 3G installations.

39. The amplifier consists of two distinct units, RF unit Type 149, which is the amplifier proper, and power unit Type 862, which provides HT and LT supplies for the RF unit. The two units are located adjacent to each other on a common base which is fixed to a mounting tray, and enclosed by a single dust cover; the cover may be removed after unscrewing the knurled nut on the top. The amplifier measures $18\frac{3}{4}$ in. wide $\times$ $10\frac{1}{4}$ in. deep $\times$ 9 in. high, and weighs 10 lb.

RF unit

40. The RF unit consists of two grounded-grid amplifying stages followed by a buffer output valve, having an overall gain of 25 dB. The input circuit is unbalanced and has an impedance of 45 ohms; the output impedance is approximately 75 ohms.

41. All components with the exception of the valves are mounted on the underside of the chassis. Shielding between cathode and anode circuits of the grounded-grid stages is provided by vertical

screens mounted across each valve-holder parallel to the grid pins of the valves.

42. The front chassis drop carries two coaxial plugs, PL3 and PL4, through which connections to the input and output circuits of the amplifier are made. A trimming tool, housed in clips attached to the front of the chassis is provided for adjusting the preset tuning capacitors, which are accessible from the upper side of the chassis. Test points are provided which enable the cathode current of each valve to be checked.

43. Power supplies are fed to the RF unit through a length of Trivin 7 cable terminated by a 6-pole Mk. 4 cable-mounted socket for connection to the power unit.

Power unit

44. The power unit delivers an HT voltage of 280V, and an LT supply of 6.3V for the valve heaters. It operates from a 110V, or 200 to 250V, 45 to 65 c/s single phase supply.

45. The power unit chassis accommodates a mains transformer, primary circuit fuses, HT rectifier valve and smoothing components. HT and LT supplies terminate at a 6-pole Mk. 4 plug (PL2) mounted on the upper side of the chassis; the plug engages with SK1 on the RF unit power supply cable.

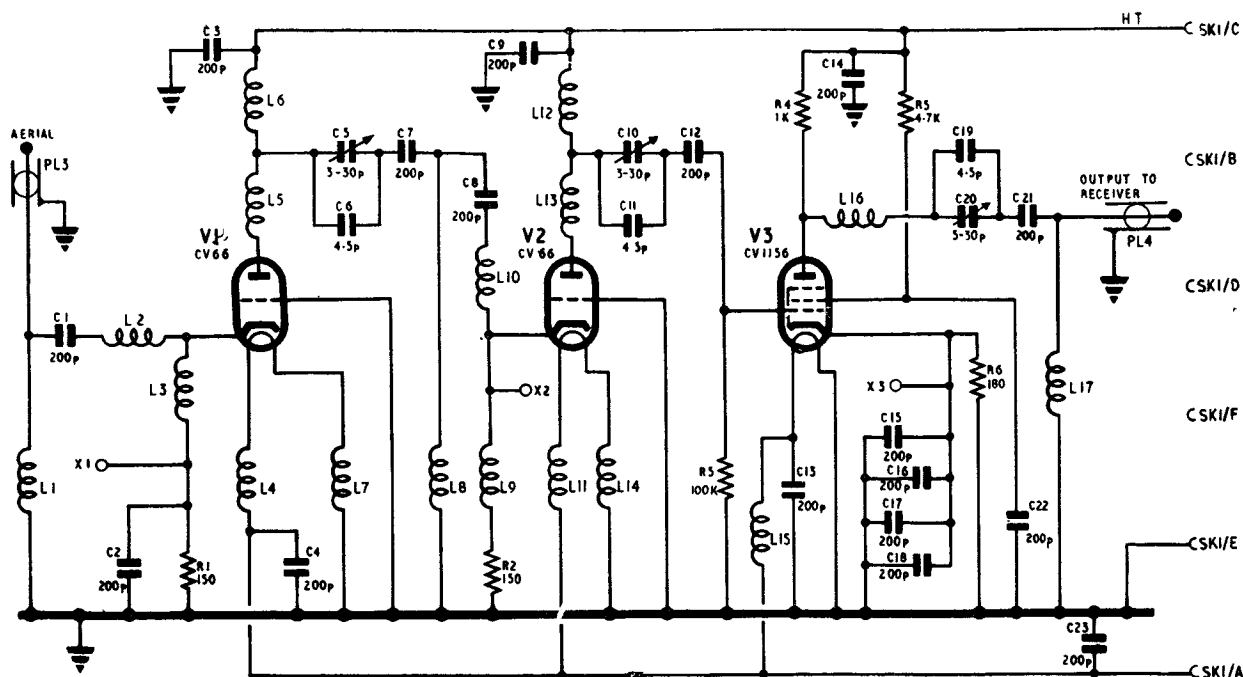


Fig. 9. RF unit Type 149—circuit

CIRCUIT DESCRIPTION

RF unit Type 149

46. The circuit of the RF unit is shown in Fig. 9.

Grounded-grid stages

47. RF input voltage is developed across the inductor L1 and applied via the blocking capacitor C1 and inductor L2 to the cathode of V1, the first grounded-grid amplifier. The tuned circuit formed by L1, C1, and L2 is broadly resonant over the range of frequencies covered by the RF unit. The grid of V1 is earthed; bias is derived from the cathode resistor R1, by-passed by C2. Shunting of the tuned circuit by R1 and C2 is prevented by the RF choke L3 connected between cathode of the valve and the bias resistor.

48. The anode load of V1 is a series-resonant circuit, consisting of L5, C5 and C6 in parallel, C7 and L8; the circuit is resonated by C5. An RF choke L6 is connected in series with the HT supply to the anode of the valve. C3, connected across the HT supply acts as an RF by-pass at this point.

49. RF voltage developed across L8 is applied to the cathode of a second grounded-grid amplifier V2, via a blocking capacitor C8 and inductor L10. Bias is derived from the cathode resistor R2, which is in series with the RF choke L9.

50. HT is applied to the anode of V2 via an RF choke L12 and the inductor L13. L13 in conjunction with C10, C11, C12 and the grid-to-cathode capacitance of V3 forms a series-tuned circuit; the circuit is tuned to resonance by C10. C9 decouples the HT supply to V2.

Buffer stage

51. The pentode valve V3 functions as a buffer, and provides little or no amplification. The output of the second grounded-grid stage is applied via C12 to the grid of V3; R3 is the associated grid resistor. The cathode bias resistor R6 is by-passed by C15, C16, C17 and C18 connected in parallel.

52. HT supply to V3 is decoupled to RF by C14, and is fed to the anode via R4, which forms a low-impedance load. The screen supply is derived through R5, with C22 acting as screen decoupling capacitor. A series-tuned circuit consisting of L16, C19 and C20 in parallel, C21 and L17 is connected between the anode of V3 and earth; the circuit is tuned to resonance by C20. RF output is taken from the junction of C21 and L17, which is a low-impedance point on the tuned circuit.

53. The heater circuits of the three valves are decoupled by the chokes L4, L7, L11, L14 and L15 in series with the heater supply loads, and the associated by-pass capacitors.

54. The test points x1, x2 and x3 enable the voltage across each cathode bias resistor to be measured to give an indication of the anode current of V1 and V2, and the combined anode and screen current of V3.

TABLE 3
Amplifier Type A.3687—test point voltages

Test Point	Voltage
x1	1.4–1.7
x2	1.4–1.7
x3	1.8–2.2

Power unit Type 862

55. The circuit of the power unit is given in fig. 8. AC mains are applied to plug PL1, and fed via the fuses F1, F2 to the tapped primary of the mains transformer T1. HT is obtained from a centre-tapped secondary winding on T1; V1 functions as a full-wave rectifier. The DC output of the rectifier is developed across the reservoir capacitor C1, which is followed by a single-section filter L1, C2.

56. LT supplies for the valve heaters are derived

from a secondary winding on T1; one side of the LT supply is connected to earth.

Test voltages

57. The limits of voltage between each test point of RF unit Type 149 and earth, measured by a testmeter Type D set to the 12V DC range are shown in Table 3.

58. Total HT voltage measured by a testmeter Type D set to the 480V DC range is within the limits 252 to 308V. The meter is connected across C2.

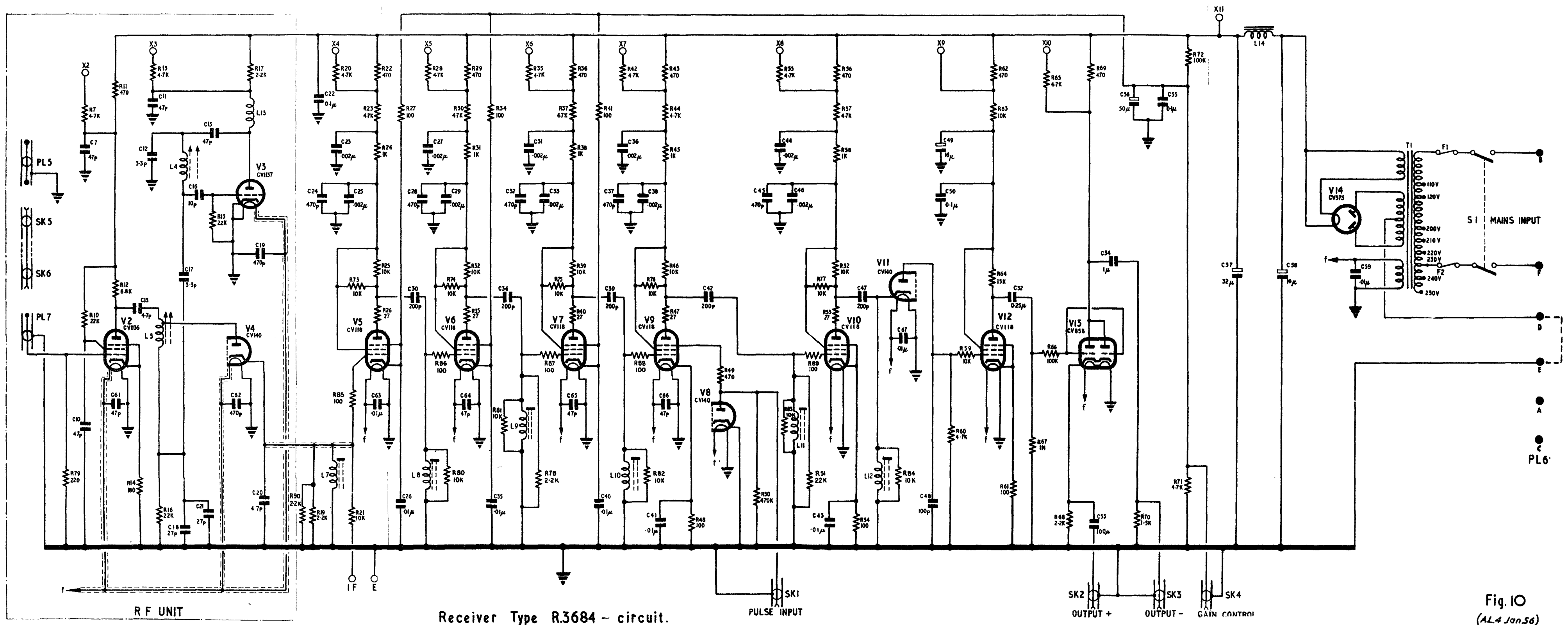


Fig. 10

Chapter 4

IFF ANCILLARIES

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JUNCTION BOX TYPE 367

Introduction

1. Junction box Type 367 (Stores Ref. 10D/18529) serves as a mains distribution panel and as a junction panel between the rack-mounted IFF equipment and cabin wiring. In addition, the junction box houses a video matching transformer, and a local gain control used for receiver testing.

2. All plugs and sockets, and the local gain control potentiometer are mounted on the face of the box (fig. 1). AC mains and 50V DC supplies are connected to a 12-pole Jones plug (PL19). Mains supplies to individual units are connected through Mk. 4 shielded sockets (SK11 to SK16). All other connections are terminated in single-pole coaxial sockets.

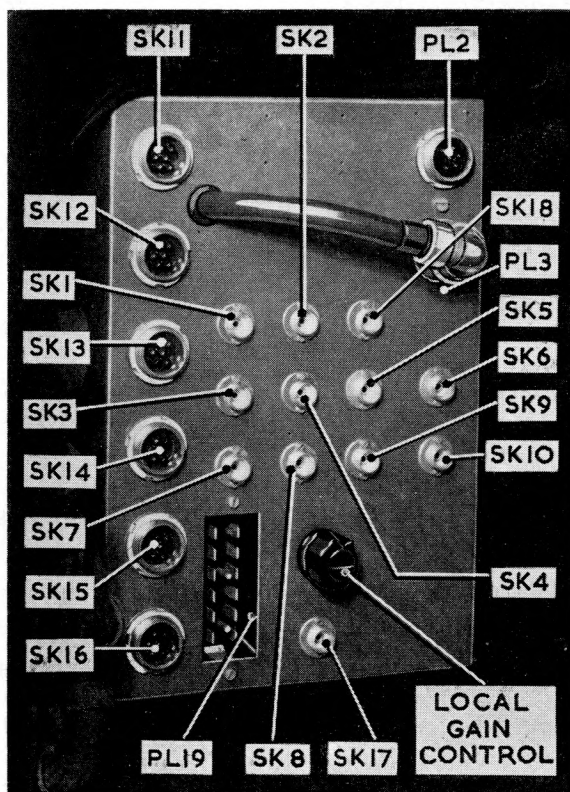


Fig. 1. Junction box Type 367

3. Inter-connections between the junction box, IFF equipment and external circuits are shown in fig. 7. The box provides for change-over from a Mk.3A to a Mk.3G system; in the present application Mk.3G only is employed, and the 6-pole cable-mounted socket is permanently connected to the G-band plug (PL3).

Mains distribution

4. AC input applied to PL19/11 and PL19/12 is fed direct to SK14/B and SK14/F (monitor Type 61) in parallel with SK15/A and SK15/F (modulator Type 239). The mains input is fed via poles B and F of the cable-mounted socket, and PL3 to the corresponding poles of SK11, SK12 and SK13, to supply transmitter Type T.3686, amplifier Type A.3687 and receiver Type R.3684 respectively.

5. The earth wire of each mains lead is connected to pole E of the relevant socket on the junction box, and to PL19/1.

Transmitter and modulator relay switching

6. The 50V DC supply applied to PL19/5 is fed to SK11/D and thence to the remote control relay in the transmitter. The remote switching lead to SK10 is connected via PL3 to SK11/C. The DC supply and switching leads to the modulator (SK15/C and SK15/D) are connected in parallel with the corresponding leads to the transmitter.

Lock in

7. Locking pulses are applied to SK7, via the change-over socket and PL3/D to SK18.

Receiver video output and gain

8. Video output from the receiver is applied to SK1 and, via PL3/E and the cable-mounted socket, to pin 3 on the auto-connected pulse transformer Type 2663; the end of the winding connected to pin 1 on the transformer is earthed. The output is taken from a low-impedance tap (pin 2) on the transformer to effect a match between the impedance of the receiver output circuit and the external video line connected to SK8.

9. The remote gain control line from the receiver is connected to SK2 and via PL3/A and the cable-mounted socket to SK9.

Local gain control

10. The local gain control is a 3,000-ohm variable resistor having a reversed-log law. The control is connected between SK17 (LOCAL GAIN) and earth.

MONITOR TYPE 61

Introduction (fig. 2)

11. Monitor Type 61 (Stores Ref. 10T/6133) is a test instrument primarily for use with transmitters Types T.3685 and T.3686. The monitor gives a visual indication on a CRT of the shape of both DC and RF pulses, and measures pulse width to an accuracy of $\pm 0.5 \mu\text{s}$.

12. Two high-speed timebases are incorporated for the measurement of pulses having a duration between $2 \mu\text{s}$ and $30 \mu\text{s}$. The timebases are triggered by the waveform of the applied pulse, which may be either positive or negative, and will synchronize

with any pulse having a recurrence frequency between 25 and 1,000 and an amplitude greater than 1 volt. A third timebase, which is sinusoidal at the frequency of the supply mains, is provided for the measurement of pulses having a duration greater than $30 \mu\text{s}$.

13. DC pulses are applied directly to the CRT. RF pulses are applied to a tuned circuit, which covers a frequency range of 150 Mc/s to 260 Mc/s, followed by a diode rectifier; the DC envelope of the pulse is produced for viewing on the CRT.

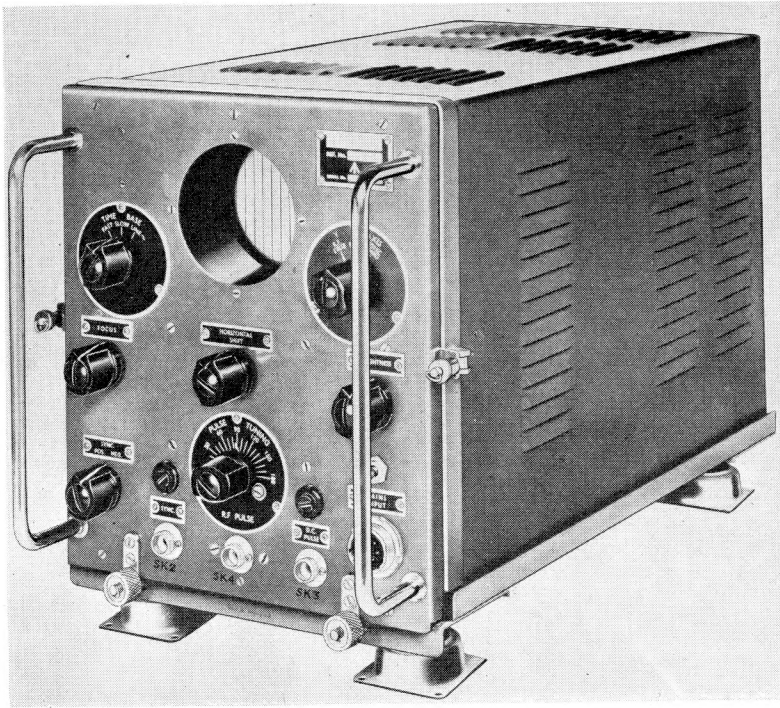


Fig. 2. Monitor Type 61

14. Pulse width is measured by comparison with a 500 kc/s damped sine-wave, which may be switched on when required.

15. The monitor operates from a 110V, or 200 to 250V 45 to 65 c/s single-phase supply.

CIRCUIT DESCRIPTION

16. When reading the following description reference should be made to the circuit diagram, fig. 8 and the voltage waveforms due to an applied synchronizing pulse shown in fig. 3.

Timebases

17. Positive or negative synchronizing pulses are applied via the socket SK2 (SYNC) to the switch S1 (SYNC). When S1 is set to the POS position, positive pulses are applied through a long time-constant circuit (C2, R5) to the grid of the pentode valve V1.

18. V1 functions as an amplifier and phase-reversing stage. Anode voltage is derived from a potential divider formed by R1 and R2 in series across the HT supply; anode circuit decoupling is by the capacitor C1. R3 forms the anode load for V1 with R4 acting as an anode stopper. The screen-grid is connected via a screen stopper R7 to the junction of two resistors R6 and R8 across the HT supply, and is decoupled by C3. The cathode of V1 is connected to earth.

19. The negative pulses at the anode of V1 are applied via S1, a long time-constant circuit (C4, R10) and a grid stopper R9 to the grid of a second amplifier, V2. R11 is the anode load for this valve, with R12 acting as anode stopper. The screen-grid is fed from the positive HT line through R13, decoupled by C6, and a screen stopper R14. Amplified positive-going pulses appear in the anode circuit of V2.

20. When S1 is set to the NEG. position, negative synchronizing pulses are applied through C4, R10 to the grid of V2, resulting in amplified positive pulses in the anode circuit of this valve.

21. The pulse in the anode circuit of V2 is applied to a differentiating circuit C5, R16, and thence through a resistor R15 to the grid of a gas-filled relay V3. HT is fed to the anode of V3 via a load resistor R18 and anode stopper R19. A capacitor C9 is connected between anode and cathode of V3 via the deflecting coils L2, L3 and the switch S2.

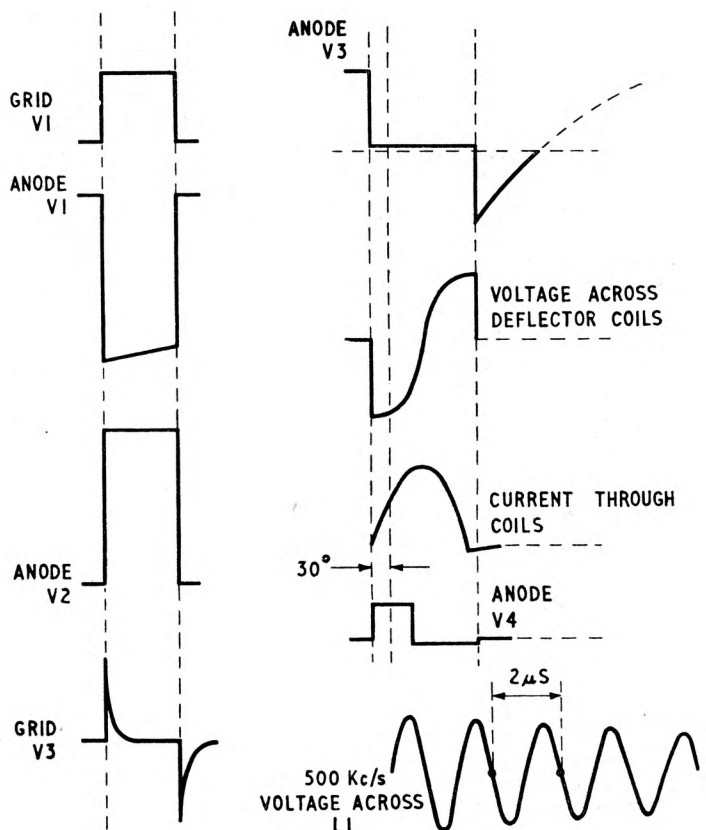


Fig. 3. Monitor Type 61—waveforms

(A.L.4, Jan. 56)

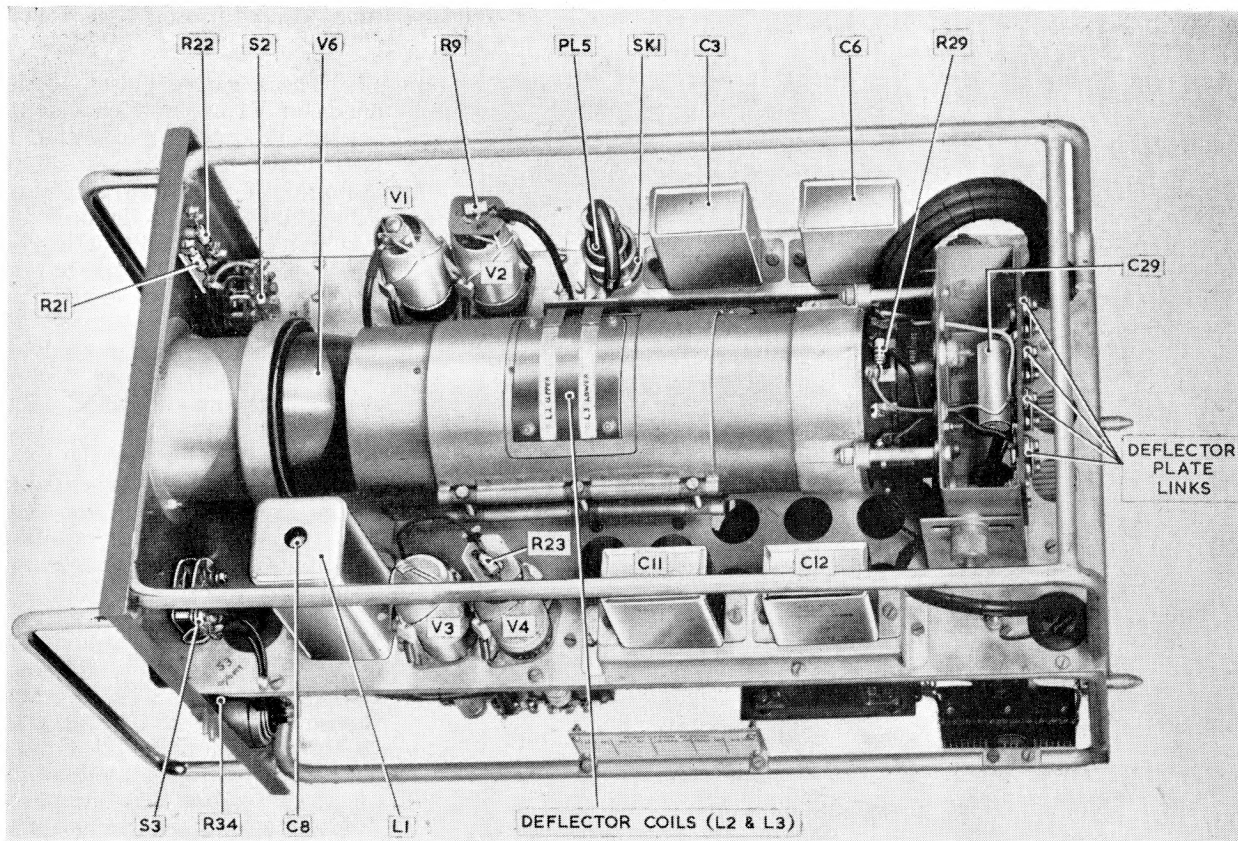


Fig. 4. Monitor Type 61—dust cover removed

22. The gas-filled relay is normally non-conducting, being cut off by the positive voltage applied to its cathode by R17 and R20 across the HT supply. R17, connected between cathode of V3 and earth, is by-passed by C10.

23. In the quiescent condition C9 charges through R18 to the maximum HT voltage. When the positive-going differentiated synchronizing pulse is applied to the grid of V3, the valve conducts; C9 discharges through V3 and the deflecting coils in series.

24. The waveform of the current through the coils due to the capacitor discharging is approximately sinusoidal. To obtain reasonable linearity, only the first 30 deg. of the waveform is used to scan the CRT; this is linear to within 5 per cent.

Brightening pulse

25. The negative half-cycle of the voltage across the coils is used to produce a brightening pulse. The negative voltage is applied via R23 to the grid of a pentode valve V4, and results in this valve being cut off during the half cycle and producing a voltage pulse of approximately 15 volts at the anode. To ensure a steep leading edge to the positive pulse at the anode of V4 an inductor L4 is connected in series with the anode load R24. HT supply to the anode and screen of V4 are obtained through R26 decoupled by C12; an additional dropping resistor R25, decoupled by C11, is included in the screen circuit.

26. The pulse at the anode of V4 is applied to the grid of the CRT, V6, through C22. The pulse occurs simultaneously with the commencement of the timebase and is maintained for the duration of the forward stroke. The positive pulse reduces the effective negative bias on the grid of the CRT, so brightening the trace for the period of the timebase sweep. The bias is adjusted so that the return stroke and waiting period are invisible.

Timebase speed

27. The three different timebase speeds are selected by the TIME BASE switch S2. When S2 is set to the first position (FAST), the deflecting coils are connected in parallel giving a timebase of $16\mu\text{s}$. In the second position (SLOW) the coils are connected in series to give a timebase of $32\mu\text{s}$. With the switch in the third position (LINE) the coils are connected in series and fed through R21 from a 4-volt winding on the mains transformer T1, to give a 50 c/s (or other frequency according to the periodicity of the supply mains) sinusoidal timebase.

28. When the 50 c/s timebase is in operation the grid of the gas-filled relay is earthed by contact on S2; additional contacts of this switch earth the grid circuit of V4 through R22. With the switch set to the other timebase positions the grid circuit of V4 is returned to earth through the deflector coils and cathode resistor of V3.

RF pulse rectifier

29. RF pulses are applied via SK4 (RF PULSE) to a tap on the tuned circuit L7, C19, which covers a

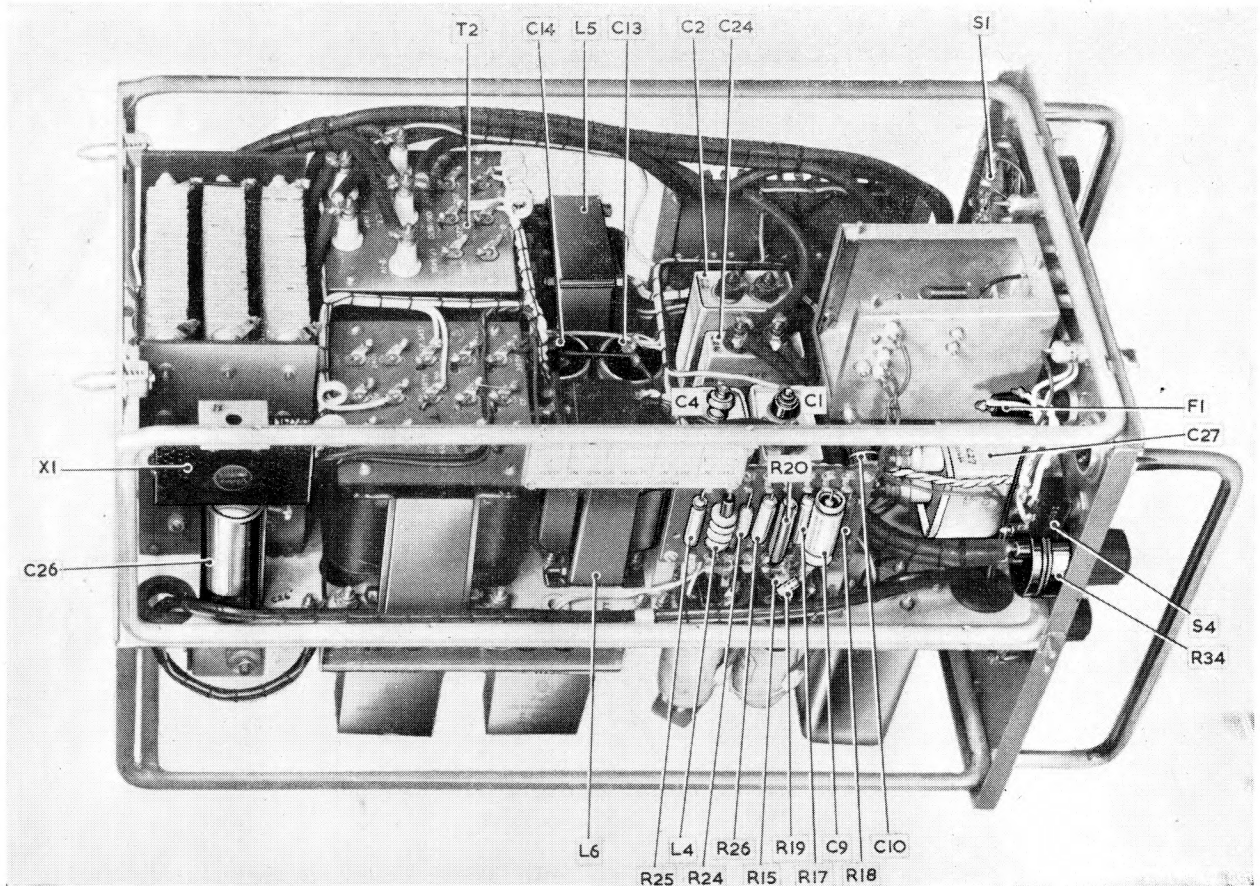


Fig. 5. Monitor Type 61—bottom and right-hand side

frequency range of 150 to 260 Mc/s; the input impedance at SK4 is approximately 100 ohms.

30. The RF pulses are rectified by the diode V5. A DC voltage corresponding in waveform to the pulse envelope is developed across the diode load resistor and capacitor R28, C20, the time constant of which is sufficiently short to prevent distortion of the pulse. The output of the rectifier is fed via an RF choke L10 to the Y AXIS switch, S3.

31. Heater voltage for V2 is derived from a low-tension secondary winding on T1. Filters consisting of the inductors L8, L9 and capacitors C15, C16, C17 and C18 are included in the heater supply leads.

Y-AXIS switch

32. In the monitor unit the CRT is rotated horizontally through an angle of 90 deg., and the X-plates used for vertical deflection. The Y-plates are used for horizontal shift only of the CRT trace.

33. The moving contact of the 3-position Y-AXIS switch S3 is connected via a link LK2 to the X2 deflector plate of the CRT; the X2 plate is returned to earth through R29 and the X1 plate is connected directly to earth. When used in this application the X-plates have a sensitivity of approximately 6 volts per mm. When the switch is set to the first position (RF PULSE) the rectified envelope of the RF pulse is

applied to the vertical deflector plates. In the second position the vertical plates are connected directly to the DC PULSE input socket SK3.

34. When S3 is switched to the third position (500 KC TIMING) the X-plates are connected across a parallel-tuned circuit L1, C8, which is pulse-excited through C7 from the anode of V3. The tuned circuit is resonated by C8 to ring at a frequency of 500 kc/s, giving a time interval of $2\mu\text{s}$ between successive peaks of the damped sine-wave so produced.

Power supplies

35. HT and LT supplies are derived from two mains transformers, T1 supplying the timebase and RF rectifier and T2, which supplies the cathode-ray tube. AC mains are applied from PL6 (Mains INPUT) via the fuses F1, F2, and double-pole switch S4 to the tapped primary of T1. The primary of T2 is auto-connected to the OV and 220V tappings on T1.

Timebase supply

36. HT supply to the timebase is derived from a high voltage secondary winding on T1 in conjunction with a bridge-connected selenium rectifier W1. The rectifier is followed by a two-section choke input filter consisting of the inductors L6, L5, and smoothing capacitors C14, C13.

(A.L.4, Jan. 56)

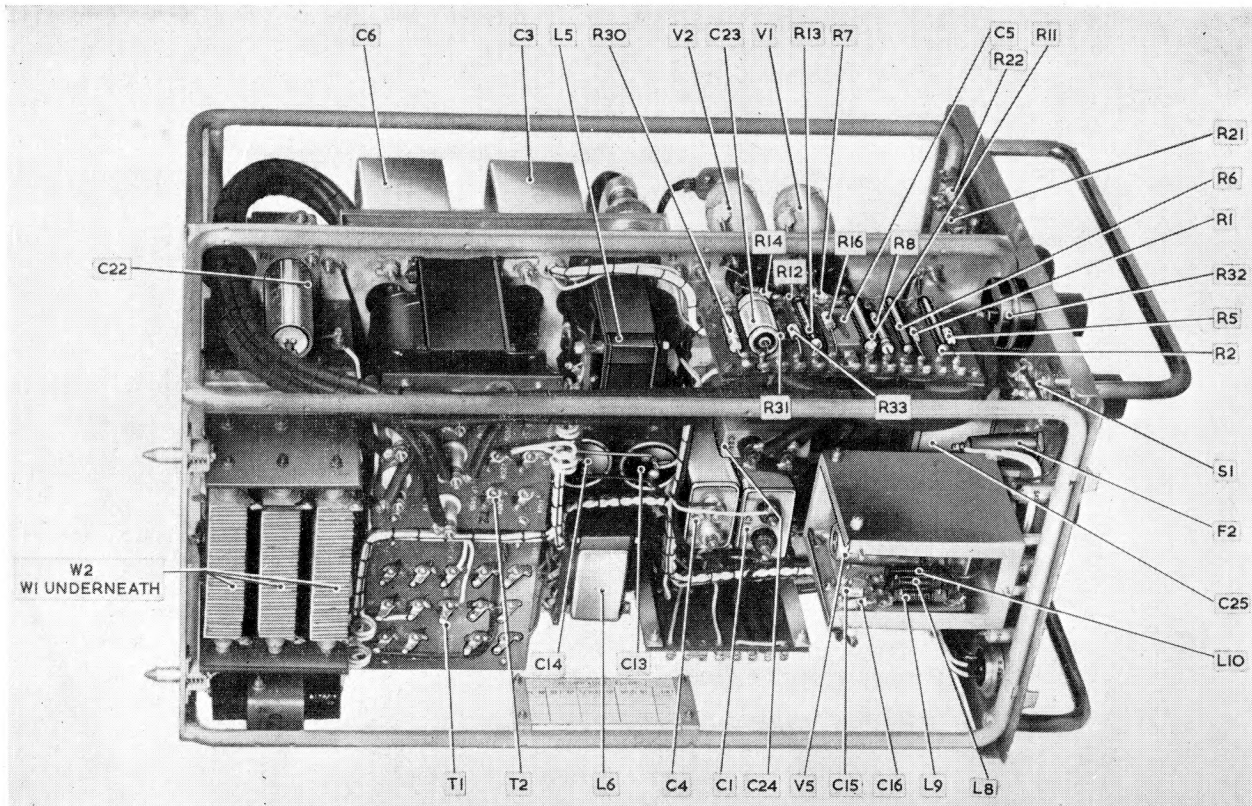


Fig. 6. Monitor Type 61—bottom and left-hand side

37. Heater supplies for V1, V2, V4 and the RF rectifier V5 are obtained from a secondary winding, the centre-tap of which is earthed.

Delay switch

38. The contact of a thermal delay switch X1 is connected in the AC supply lead to one side of W1. The switch provides a delay of approximately 50 seconds to prevent the application of HT voltage during the cathode heating time, which would result in damage to the gas-filled relay valve V3. The delay switch is heated from a low-tension winding on T1; the winding also supplies heater voltage to V3.

CRT supplies

39. The EHT supply for the CRT is obtained from a high-voltage secondary on T2. Rectification is by the voltage doubler, consisting of a selenium rectifier W2 in conjunction with C26 and C27. The DC output of the rectifier is developed across C26 and C27 in series, and is smoothed by a resistance-capacitance filter R35, C25. A potentiometer consisting of R31, R32, R33 and R34 in series is connected across the EHT supply, the positive side of which is earthed.

40. The 1st and 3rd anodes of the CRT are connected to earth (positive EHT). The 2nd anode is taken to the slider of the potentiometer R32, which forms the FOCUS control. C23 is a by-pass between 2nd anode and cathode of the tube.

41. The cathode is connected to the junction of R33 and the potentiometer R34, therefore the voltage across R34 is negative with respect to the cathode. R34 is variable and thus controls the negative bias applied to the grid. The grid circuit is decoupled by R30 and the by-pass condenser C24.

42. The Y2 and X1 deflector plates are returned to earth via the links LK3 and LK4 respectively. The Y1 plate is connected via the link LK1 to a variable positive voltage derived from the slider of the potentiometer R27, which is in series with R26 across the timebase HT supply. R27 forms the HORIZONTAL SHIFT control. The Y1 deflector is by-passed to earth by C21.

43. The heater voltage for the CRT is derived from a low-voltage secondary on T2; the centre-tap of the winding is connected to the cathode of the tube.

Test voltages

44. The permissible limits of voltage at various positions in the circuit of the monitor are shown in Table 1. All voltages are measured with a testmeter connected between the position indicated and earth. EHT supply is measured on an electrostatic voltmeter. All other measurements are made on a testmeter Type D set to the range indicated in the table.

TABLE 1
EHT and HT voltage readings

Position in circuit	Testmeter range (V)	Reading (V)	Position of TIMEBASE switch
Junction of R35 and C25 (EHT)	—	2.25kV $\pm 10\%$	
Junction of L5 and C13 (HT)	1,200	430 $\pm 10\%$	
V1 anode	120	6	} $\pm 30\%$ FAST and SLOW LINE FAST and SLOW LINE FAST and SLOW LINE
V1 screen	480	110	
V2 anode	120	13	
V2 screen	480	160	
V3 anode	1,200	400	
V3 cathode	480	35	
V3 cathode	480	50	
V4 anode	1,200	320	
V4 anode	1,200	350	
V4 screen	480	40	
V4 screen	480	90	

CONSTRUCTIONAL DETAILS

45. The monitor is housed in a ventilated dust cover and fitted in a shock-absorbing mounting tray from which it may be removed after loosening the two swivelling screws at the front. All controls and plug and socket terminations are mounted on the front panel. The chassis and panel may be removed from the dust cover after loosening the swivelling screw at each side of the panel.

46. The monitor measures 10 in. wide $\times$ 11½ in. high $\times$ 19 in. deep and weighs approximately 70 lb.

47. A top chassis view with the dust cover removed is shown in fig. 4. The CRT is enclosed in a mu-metal shield which has two rectangular sections cut out above and below the neck of the tube. The deflector coils are positioned in the tube. The deflector coils are positioned in the cut-away sections and are held in place by two semi-circular mu-metal clamps. The clamps are hinged at one side and secured together by three captive screws at the other side of the tube shield. External connections to the coils, above and below the tube, are made through spring contacts and via a flexible cable-mounted socket SK1 to the plug PL5, which is located on the chassis.

48. The tube base is mounted on a vertical bracket at the rear of the chassis. The tube and deflector coil assembly may be removed after first loosening the knurled-head nut at each side of the brackets, sliding the tube and coils to the rear and undoing the three screws by which the shield is fixed to the bracket. The coils may be removed from the neck of the tube after undoing the three screws which hold together the two halves of the mu-metal clamp.

49. The tube may be rotated to position the trace horizontally after loosening the three milled nuts by which the tube base is attached to the mounting bracket.

50. The removable deflector plate links are mounted on an insulating strip at the rear of the mounting bracket. The links are accessible through a hole, normally closed by a hinged cover, at the rear of the unit.

51. Fig. 5 and 6 show underside chassis views with the components annotated. The RF rectifier and associated components are mounted in a shielded compartment. The illustrations show the RF unit with the L-shaped cover removed.

AERIALS, FEEDERS AND CONNECTORS

Aerial and feeder system

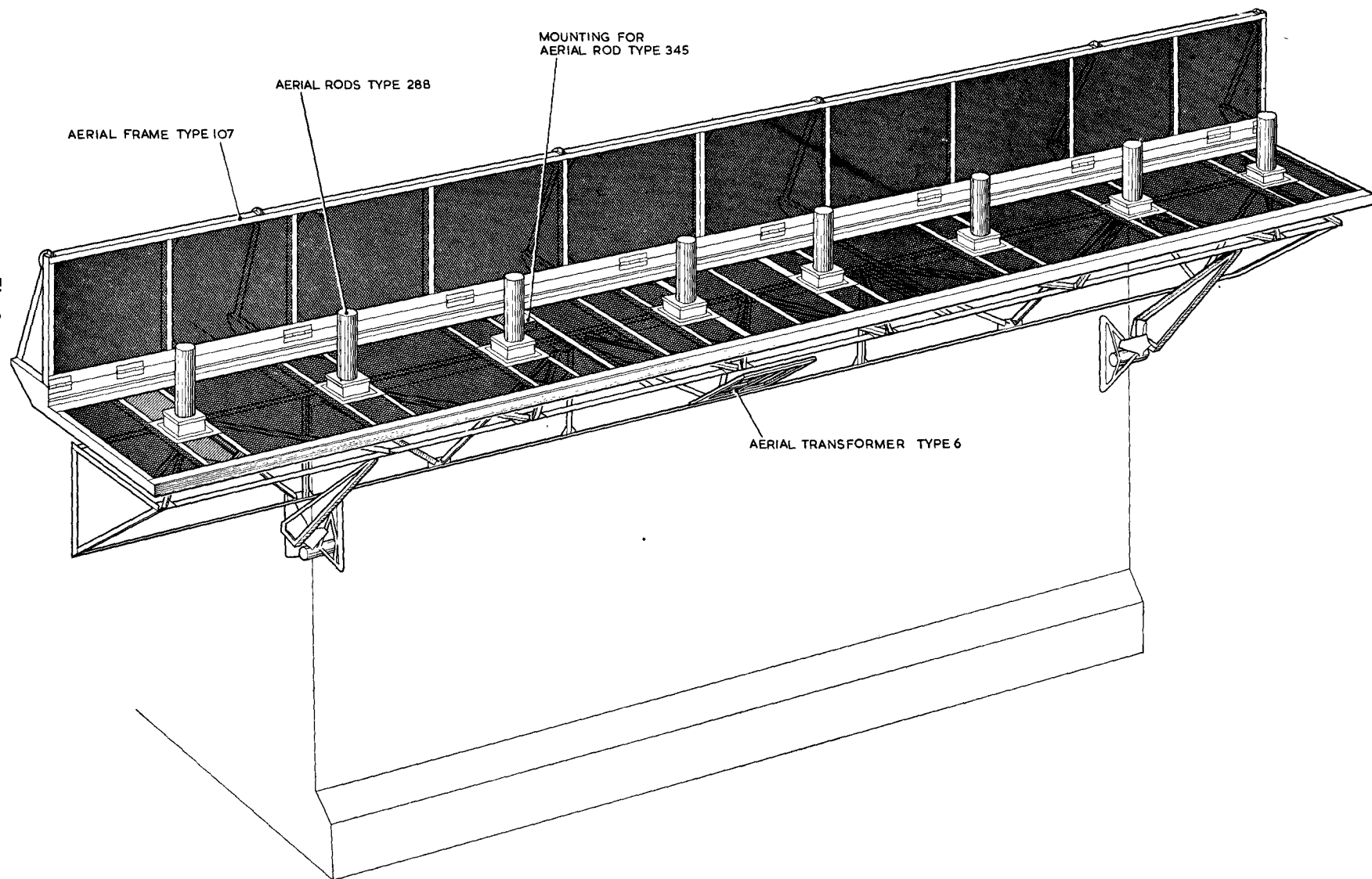
52. The common transmitting and receiving aerial system fitted to radar Type 79 consists essentially of a wide-band broadside array, formed by eight end-fed unipoles mounted in front of an L-shaped reflector and earth screen (fig. 9). The eight elements are connected to the equipment in the radar cabin through an unbalanced feeder and matching system. Change-over from transmit to

receive is achieved by a spark-gap type of TR switch unit.

53. A single vertical unipole, mounted in front of the reflector, is employed as a pick-up aerial for monitoring the power output of the IFF transmitter.

54. A list of the equipment comprising the aerial, feeder and transmit-to-receive change-over systems is shown in Table 2.

Fig. 9. Radar Type 79—airial array



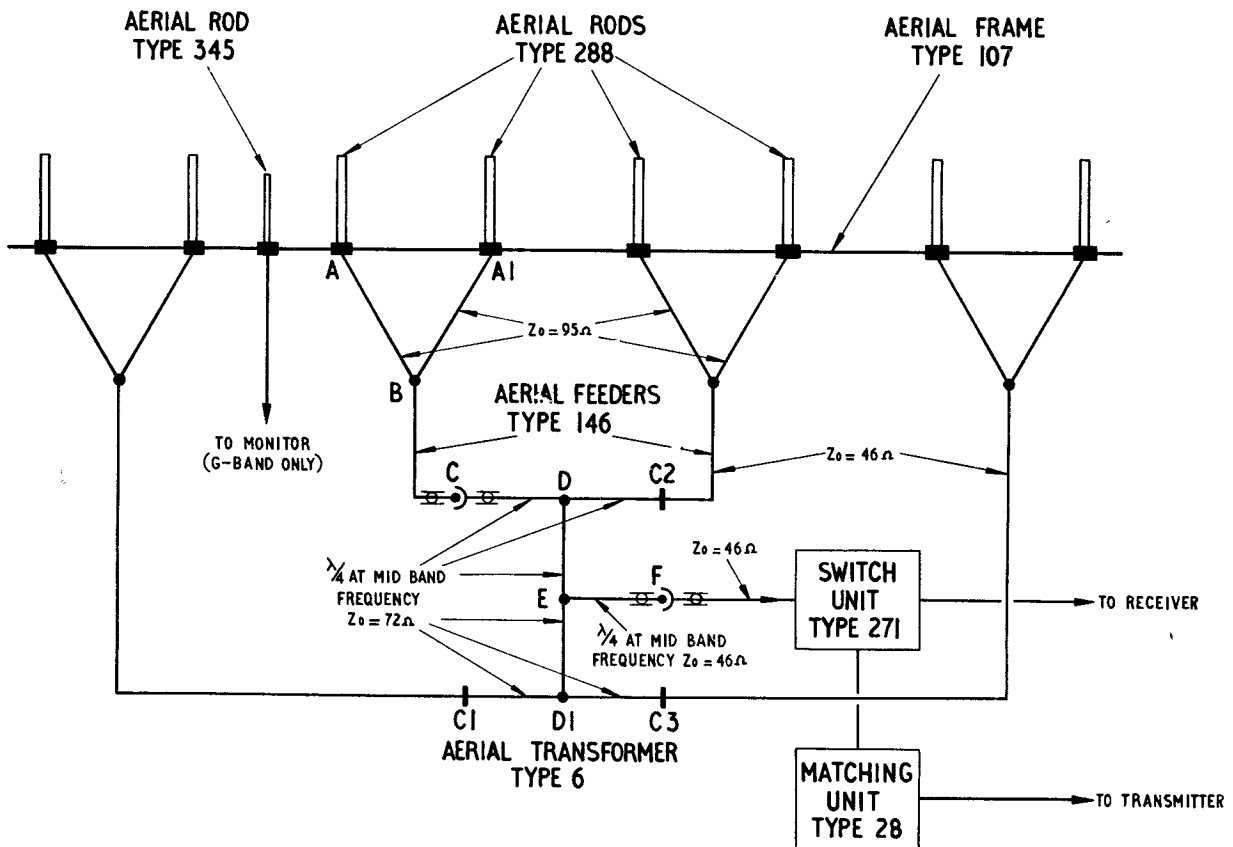


Fig. 10. Functional diagram of aerial and feeder system

TABLE 2
Aerial Equipment

Designation	Quantity	Stores Ref.
Rod, aerial Type 288	8	10BB/3664
Rod, aerial Type 345	1	10BB/6701
Frame, aerial Type 107	1	10BB/6842
Feeder, aerial Type 146	4	10BB/3657
Transformer, Aerial Type 6	1	10BB/3662
Connector, moulded Type 3367/1	2	10HA/11154
Aerial connector panel	1	—
Switch unit Type 271	1	10FB/6247
Matching unit Type 28	1	10AB/8538

55. A functional diagram of the aerial and feeder system is shown in fig. 10. Consider the two elements A and A1. The unipoles, which have an impedance of 95 ohms at the feed point, are connected to 95-ohm feeders AB and A1B. As the two feeders are in parallel at B, this point has an impedance of 47.5 ohms, which is an approximate match to the 46-ohm feeder BC.

56. CD, C2D and DE are $72\text{-ohm } \frac{\lambda}{4}$ lines, which function as impedance transformers. It can be shown (AIR PUBLICATION 1093E, Vol. 1, 2nd Edn., Chap. 4) that the input impedance Z_s of a loss-free line $\frac{\lambda}{4}$ long and terminated by an impedance

Z_R is given by the relation

$$Z_s = \frac{Z_o^2}{Z_R} \dots\dots\dots(1)$$

in which Z_o is the characteristic impedance of the $\frac{\lambda}{4}$ line.

57. From the above equation,

$$Z_o = \sqrt{Z_s Z_R} \dots\dots\dots(2)$$

and thus a load of impedance Z_s may be matched to another load of impedance Z_R by inserting between them a $\frac{\lambda}{4}$ line having a characteristic impedance equal to the geometric mean of the two impedances. Under these conditions the $\frac{\lambda}{4}$ line is not correctly terminated and a standing-wave will exist along it; as the $\frac{\lambda}{4}$ line is much shorter than the feeders the presence of the standing-wave is not detrimental.

58. In the present application, the 46-ohm impedance of the feeder connected to C is converted to 113 ohms at D. Similarly, the unipoles connected through a feeder to C2 present an impedance of 113 ohms at D. The resultant impedance at D is therefore that of the two 113-ohm impedances in parallel, that is, 56.5 ohms. This impedance is transformed to 92 ohms at E by the $\frac{\lambda}{4}$ section DE.

(A.L.4, Jan. 56)

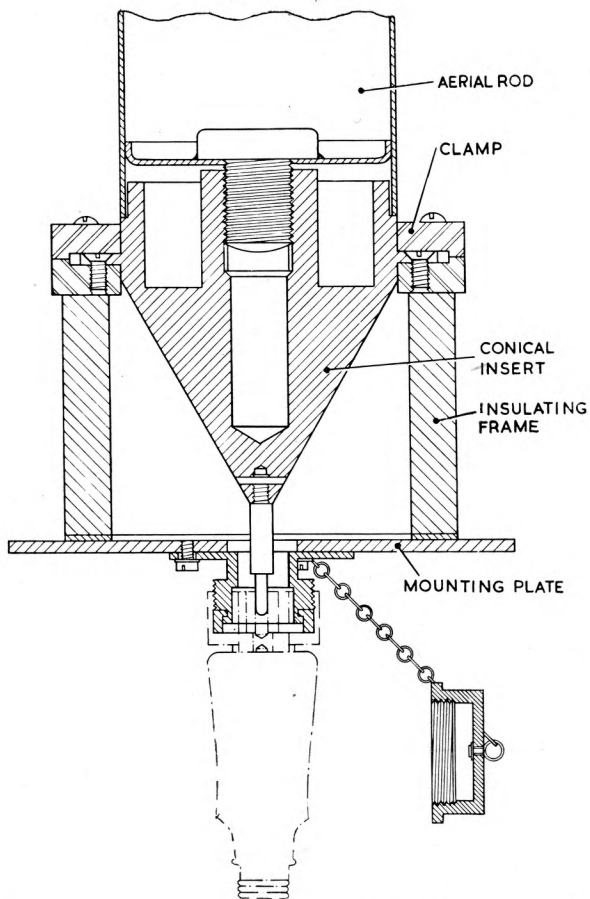


Fig. 11. Aerial rod Type 288—sectional view of mounting

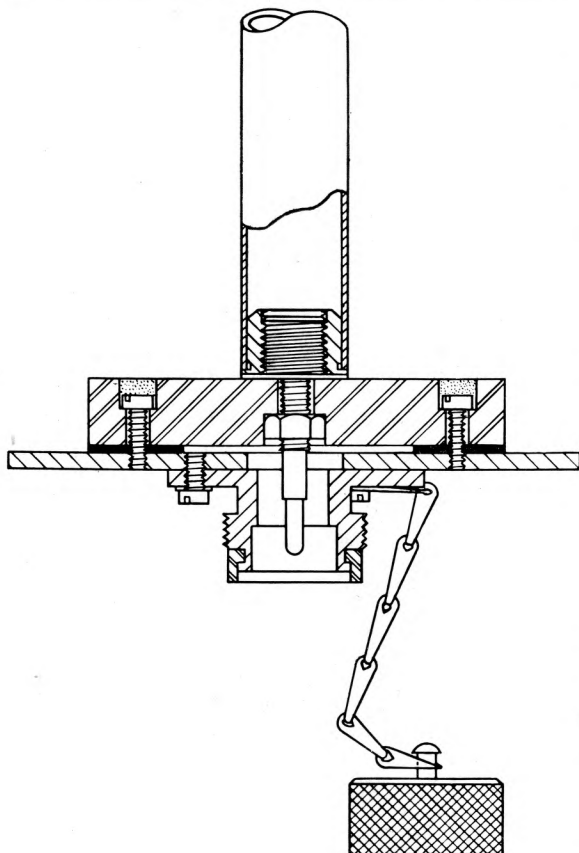


Fig. 12. Aerial rod Type 345—sectional view of mounting

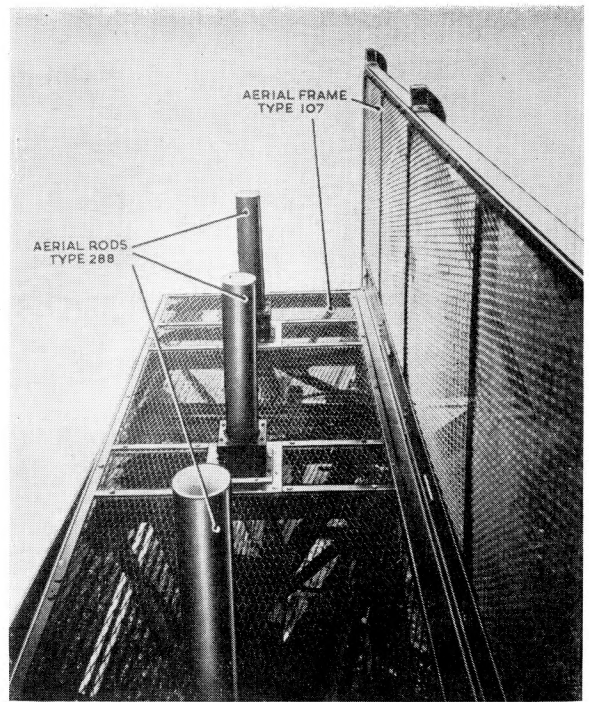


Fig. 13. Aerial frame Type 107

59. Similar reasoning can be applied to the pairs of unipoles connected to C1 and C3. The resultant impedance at E is therefore 46 ohms, that is, two impedances of 92 ohms connected in parallel.

60. The $\frac{\lambda}{4}$ line EF has an impedance of 46 ohms; this line therefore acts as a unity-ratio impedance transformer between the 46-ohm impedance at E and the 46-ohm feeder connected between F and the switch unit.

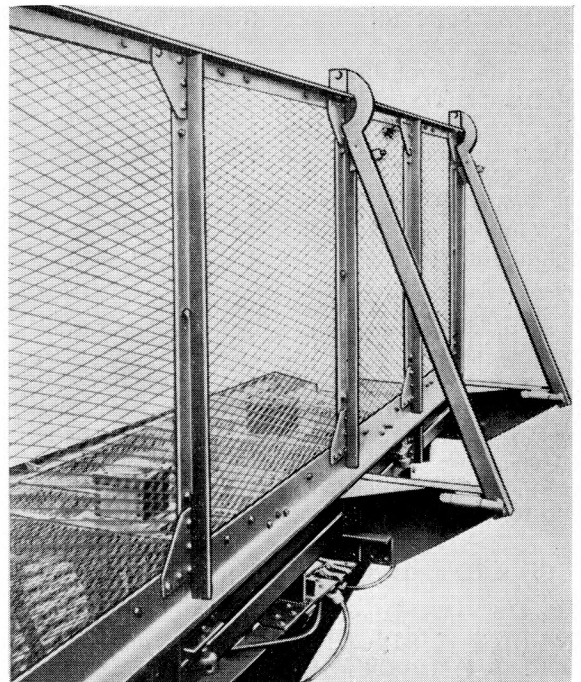


Fig. 14. Aerial frame Type 107—rear view

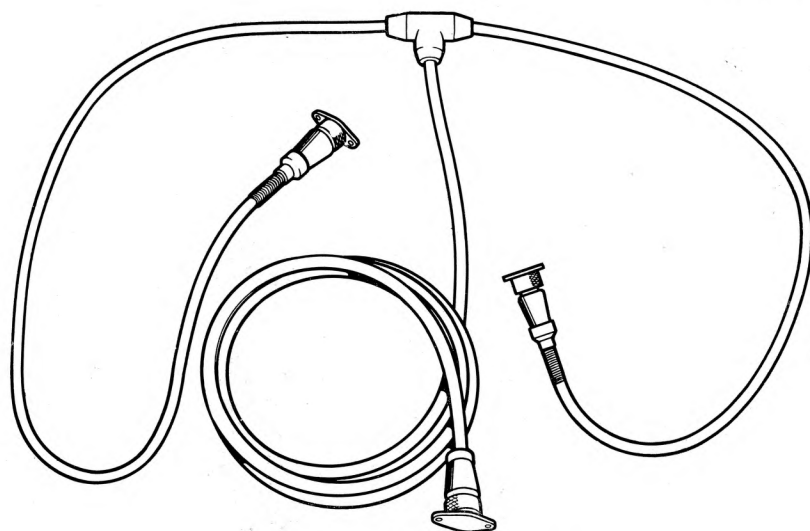


Fig. 15. Aerial feeder Type 146

Aerial rod Type 288

61. Aerial rod Type 288 is a wide-band unipole, eight of which are employed in the IFF aerial array fitted to radar Type 79. The rod is 15 in. long and 3 in. in diameter, and is constructed of aluminium tube. The upper end of the tube is sealed by a circular aluminium plate; the lower end carries a threaded spindle by which the rod is screwed to the aerial mounting.

62. The aerial mounting consists of an inverted conical metal insert, clamped in a square wooden insulating frame fitted to a metal base plate (fig. 11). A threaded hole is located centrally in the upper face of the insert into which the spindle of the aerial rod is screwed. The apex of the cone is connected to a single-pole coaxial plug fitted with a detachable waterproof cap; the plug is screwed to the underside of the mounting plate.

Aerial rod Type 345

63. The monitor aerial consists of a No. 14 Rollet tube 11 in. long, the upper end being sealed. The lower end of the tube is fitted with a threaded insert.

64. The aerial mounting (fig. 12) consists of a square paxolin base on the upper face of which a threaded boss is located centrally. The aerial rod is screwed on to the boss, which is integral with a single-pole coaxial plug projecting from the underside of the paxolin sheet; the plug is fitted with a waterproof cap. The mounting is secured to the aerial frame by four screws.

Aerial frame Type 107 (fig. 13)

65. The reflector and earth screen consists of an L-shaped frame constructed of aluminium angle section, covered with aluminium mesh. The frame is 20 ft. in length; the screen is 3 ft. 6 in. wide and the reflector is approximately 3 ft. high. The aerial rods are fitted to mounting plates 2 ft. 6 in. apart, at a distance of $15\frac{3}{4}$ in. in front of the reflector. The base of each rod is secured to the mounting plate by eight screws.

66. When operational, the reflector is held in a vertical position by six struts at the rear of the frame (fig. 14). For transit, the struts are swivelled to a

horizontal position and secured to the frame by captive screws.

Aerial feeder Type 146 (fig. 15)

67. The eight elements of the aerial array are connected in pairs to the aerial transformer through

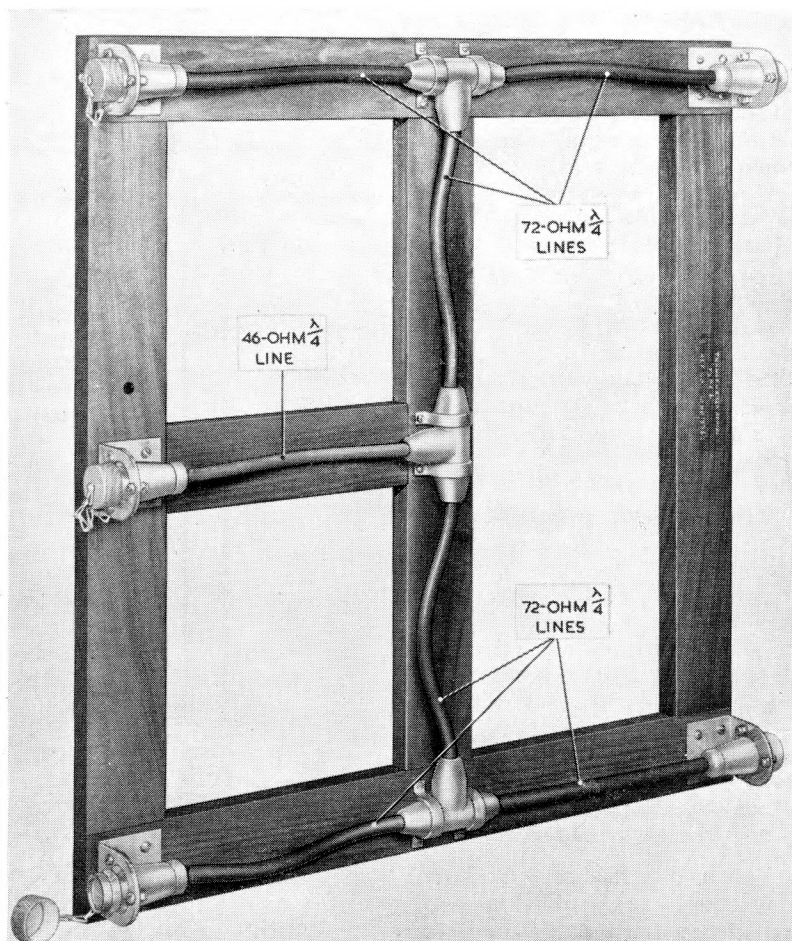


Fig. 16. Aerial transformer Type 6

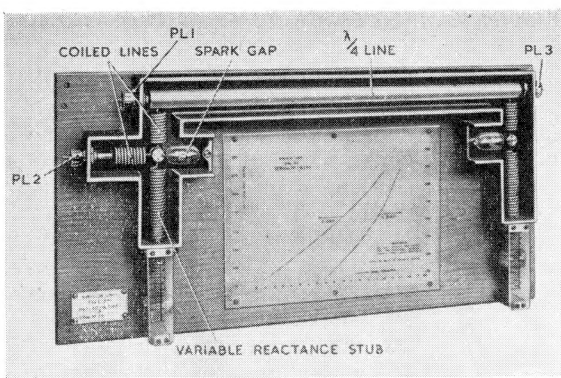


Fig. 17. Switch unit Type 271

a T-feeder, four of which are used in the present application. The feeder consists of two 95-ohm coaxial lines 3ft. 4in. long, and a 46-ohm coaxial line 8ft. 9in. long connected at a T-junction. The free end of each 95-ohm line is terminated by a moulded type single-pole socket for connection to the plug on the aerial base. The 46-ohm line is terminated by a similar socket for connection to the aerial transformer.

Aerial transformer Type 6 (fig. 16)

68. The $\frac{\lambda}{4}$ coaxial lines comprising the aerial transformer are mounted on a wooden frame. Tee-junctions between the lines are enclosed in polythene mouldings. All terminations of the transformer are moulded polythene coaxial plugs, fitted with detachable covers. The lines are secured to the frame by angle brackets fitted to each terminating plug and held rigid by saddles which clamp the polythene moulding of each Tee-junction to the frame.

Moulded connector Type 3367/1

69. The moulded connector is a coaxial RF feeder constructed of Uniradio 4 cable having a characteristic impedance of 45 ohms. Two connectors are employed in the IFF Mk.3G installation on radar Type 79. One connector serves as a feeder between the aerial transformer Type 6 and the aerial connector panel (para. 71); the other is used as a feeder between the monitor aerial (rod aerial Type 345) and the aerial panel.

70. The connector is terminated at one end by a moulded type of socket, fitted with a locking ring; this socket is connected to the output plug on the aerial trans-

former or the plug on the aerial base, according to the application. The other end is terminated by a telconnector plug for connection to a similar type of socket on the aerial connector panel.

Aerial connector panel

71. The aerial connector panel, fitted to the end of the radar cabin, forms the junction between the internal feeders and the external feeders to the aerals (para. 69). The panel is constructed of steel and measures 6½ in. by 5½ in. The joint between the cabin and the panel is rendered airtight by sealing compound.

72. The panel has two holes through which the Telconnector terminations on the internal feeders (items No. 21 and 22 in the connector set) are fitted

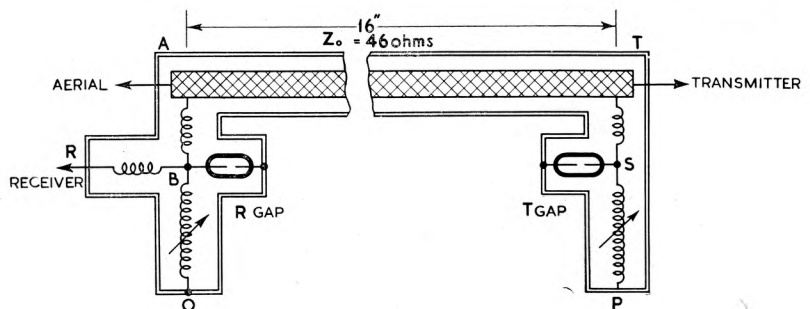


Fig. 18. Switch unit Type 271—diagrammatic representation

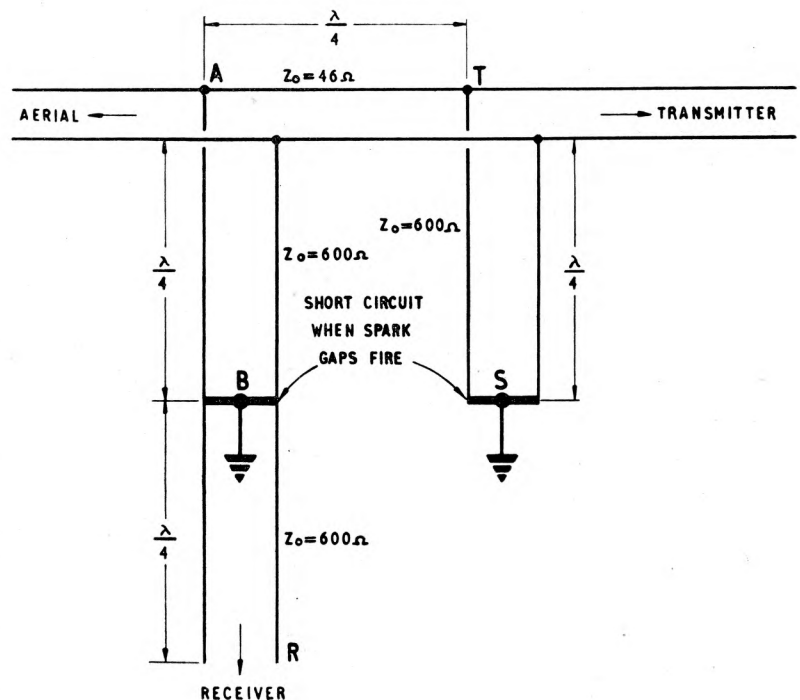


Fig. 19. Transmitting condition

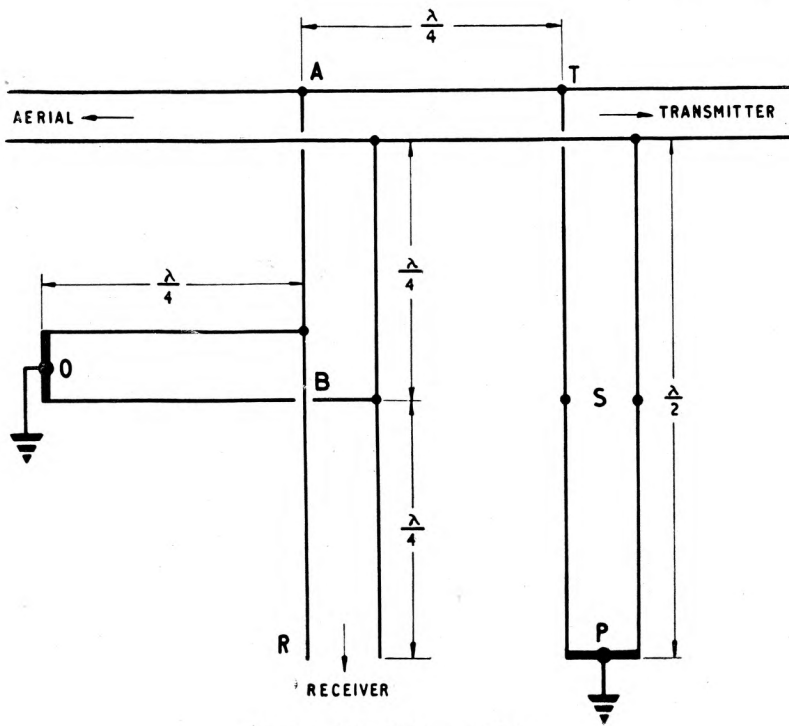


Fig. 20. Receiving condition

To fit the Telconnectors, the threaded flange is removed from each connector and bolted to the panel from the outside. The end of the connector is then inserted in the flange from the inside of the cabin and secured by the locking ring. Panel designations SK1 and SK2 indicate the termination appropriate to the monitor aerial and the aerial transformer respectively.

73. Two threaded end-caps are attached to the exterior of the panel and are used to render the terminations air-tight when the external feeders are not fitted.

Switch unit Type 271

74. Switch unit Type 271 is an unbalanced T and R switch designed to cover the entire IFF Mk. 3 frequency band, and to operate with a transmitter power of between 1 and 10kW. The switch is of the spark-gap type, and makes use of the characteristics of open and short-circuited resonant lines to obtain the correct conditions.

75. A general view of the switch unit is shown in fig. 17 and a functional diagram in fig. 18. The aerial, transmitter and receiver are connected to A, T and R respectively. The unbalanced trough line AT between the aerial and transmitter terminations is $\frac{\lambda}{4}$ long at the mid-band frequency, and has a characteristic impedance of 46 ohms.

76. Coiled lines AB and RB are connected from the aerial and receiver terminations

respectively to the R-gap. A similar line TS is connected between the transmitter termination and the T-gap. The coiled lines are electrically $\frac{\lambda}{4}$ long, and have an impedance of 600 ohms; they are necessary to step up the voltage and ensure that the gaps fire with the low power used.

77. Variable reactance $\frac{\lambda}{4}$ stubs

BO and SP are connected at B and S respectively. The electrical length of each stub may be varied; this is accomplished by a metal screw-thread having the same pitch as the coil, traversing the inside of the winding and successively short-circuiting to earth the turns of the coil. A knob is attached to each screw which, in conjunction with a graduated scale, enables the position of the screw to be determined to one tenth of a turn.

78. The switch unit is mounted on a wooden base-board. All terminations are made through coaxial plugs, PL1 (aerial), PL2 (receiver) and PL3 (transmitter).

Transmitting condition (fig. 19)

79. In the transmitting condition, the T and R spark gaps fire. The lines AB and TS are thus shorted at B and S respectively, and present a high impedance at A and T. Power is thus transmitted via the line AT from transmitter to aerial, but does not affect the receiver due to the high impedance at the sending end of the line AN, and the effective shorting of the input to the receiver.

80. At frequencies other than the mid-band frequency the coiled lines AB and TS will be slightly greater or less than $\frac{\lambda}{4}$, and a mismatch will be introduced. Over the range of frequencies employed the mismatch will be so slight that it can be neglected.

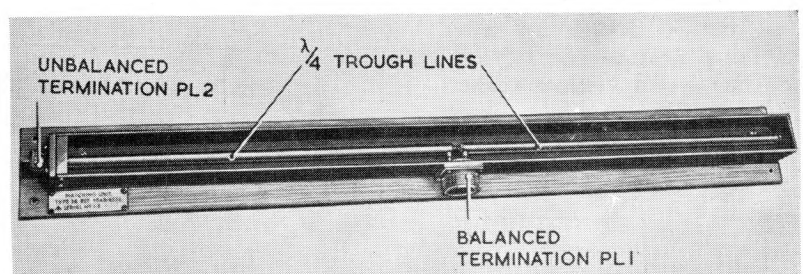


Fig. 21. Matching unit Type 28

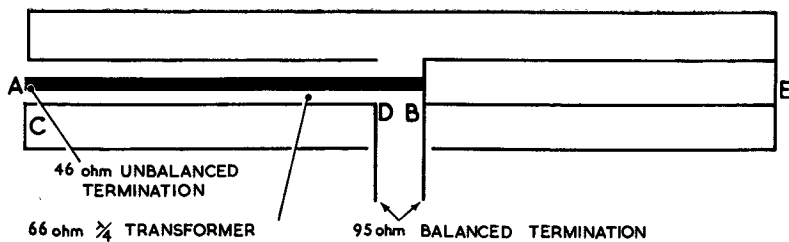


Fig. 22. Matching unit Type 28—construction

Receiving condition (fig. 20)

81. In the receiving condition the spark gaps are quiescent. Consider firstly operation at the mid-band frequency. The stub SP is adjusted to $\frac{\lambda}{4}$, so that the total electrical length of TS and SP is $\frac{\lambda}{2}$; as a $\frac{\lambda}{2}$ line acts as a 1 to -1 transformer, the point T is at earth potential. AT is $\frac{\lambda}{4}$ long, and therefore a high impedance is presented at A.

82. The total length of the stubs RB and AB is $\frac{\lambda}{2}$; therefore points A and R have the same impedance and the 46-ohm impedance of the aerial feeder at A is transferred to the input of the receiver connected to R.

83. At other frequencies it is necessary to compensate for the fact that AB, RB and AT are not $\frac{\lambda}{4}$ long. It is possible to maintain the matching from the aerial to the receiver by the addition of reactance of the appropriate sign at B; this is provided by the adjustable stub OB.

Matching unit Type 28

84. Matching unit Type 28 (fig. 21) is a device used for matching unbalanced lines having a characteristic impedance of 46 ohms to balanced 95-ohm lines, using the principles of the balun or quarter wavelength collar.

85. Functional diagrams of the unit are shown in fig. 22 and 23. Coaxial conductor AB and CD form an unbalanced-to-balanced transformer having a characteristic impedance of 66 ohms. This effect an impedance match between the unbalanced 46-ohm line connected at AC and a balanced 95-ohm line connected at BD. The outer trough of the matching unit to the left of the balanced termination

forms the quarter wavelength collar which converts the unbalanced line at AC to a balanced line at BD.

86. Currents in the quarter wavelength collar produce unbalanced currents in the load and to improve the balance a further stub (formed by the conductor BE in the trough) is connected to the balanced termination at B. The reactance of the line BE is thus in parallel with one half of the load RL, and the reactance of CD is in parallel with the other half. As the effective reactances are the same, the currents flowing through each half of the load (RL/2) are more equal and a better balance is achieved.

87. The short-circuited $\frac{\lambda}{4}$ lines BE and CD consist of an inner tubular conductor in a square section trough. The balance-to-unbalanced transformer is formed by the inner tube of the line CD, in conjunction with a coaxial inner conductor AB.

88. The balanced line is connected to a 2-pole screened plug (PL1). The unbalanced line is connected to a coaxial plug (PL2). The matching unit is mounted on a wooden baseboard.

Connector set

89. The connector set comprises the internal aerial feeders and inter-unit connectors for the IFF equipment. All connectors bear an identification sleeve at each end. The first three figures on the sleeves denote the number of the connector; with the exception of the modulator input trigger lead (item 3 in the table), the fourth and fifth figures indicate the number of the plug or socket on the unit with which the connector engages. Details of the connector set are given in Table 3.

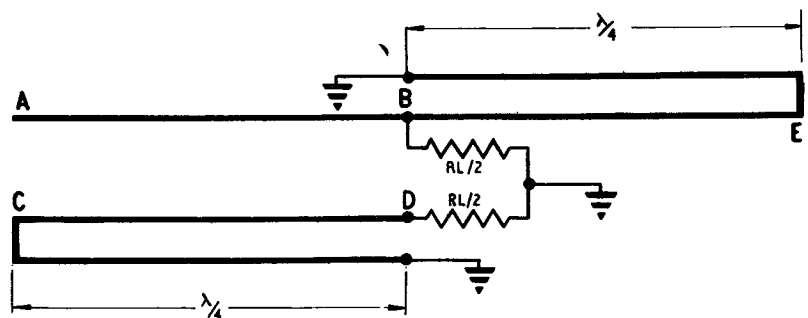


Fig. 23. Matching unit Type 28—functional diagram

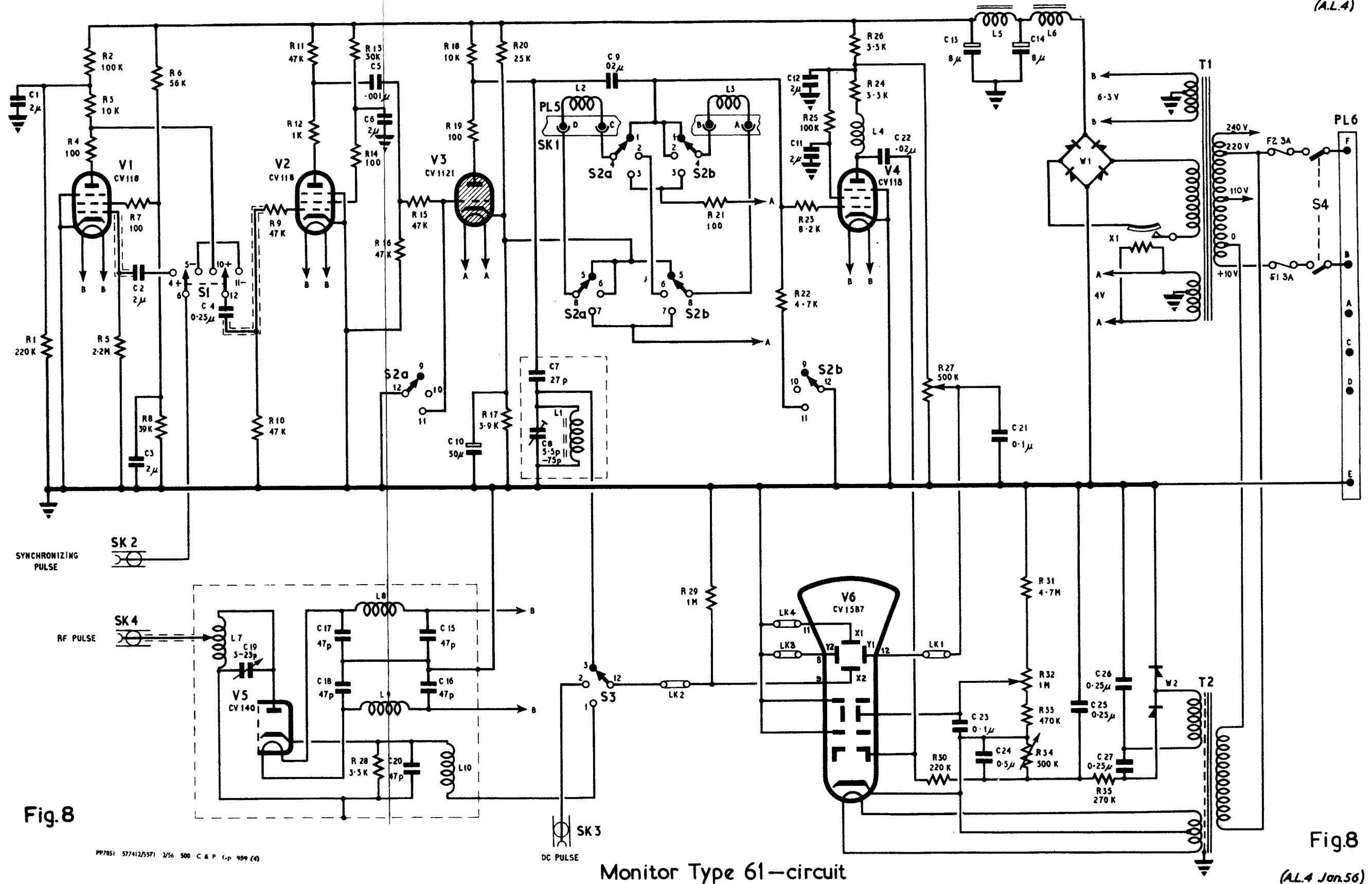


Fig.8

Fig.8

Monitor Type 61—circuit

TABLE 3
Connector set

Item No.	Type of Cable	Edn. 'A' No.	Connected to	Edn. 'B' No.	Connected to	Length (inches)	Type	Stores Ref.
1	Uniradio 32	3002	SK2 on R.3684	3001	SK1 on JB.367	56·5	9176	10HA/9817
2	Uniradio 32	3014	SK4 on R.3684	3012	SK2 on JB.367	52·5	9177	10HA/9818
3	Uniradio 32	3042	SK4 on M.239	3045	SK18 on JB.367	104	9180	10HA/9821
4	Uniradio 32	3073	SK3 on M.239	3072	SK2 on monitor 61	53·5	9183	10HA/9824
5	Uniradio 32	3084	Test points on M.239	3083	SK3 on monitor 61	46·5	9184	10HA/9825
6	Trivinseven	3096	PL6 on R.3684	30913	SK13 on JB.367	48·5	9185	10HA/9826
7	Trivinseven	3111	PL1 on A.3687	31112	SK12 on JB.367	38	9187	10HA/9828
8	Trivinseven	3126	PL6 on monitor 61	31214	SK14 on JB.367	54	9189	10HA/9829
9	Sextocoremctvin small	3136	PL6 on M.239	31315	SK15 on JB.367	59	B16/20C/1	10HA/11108
10	Sextocoremctvin small	3146	PL6 on T.3686	31411	SK11 on JB.367	5·5	B16/20C/2	10HA/11109
11	Uniradio 21	3154	PL4 on A.3687	3155	PL5 on R.3684	52·5	11110	10HA/11110
12	Uniradio 4	3163	PL3 on A.3687	3162	PL2 on SU.271	146·5	9258	10HA/11111
13	Uniradio 4	3182	PL2 on MU.28	3183	PL3 on SU.271	50·5	9260	10HA/11113
14	Uniradio 4	3202	Telcon 2 on ACP	3201	PL1 on SU.271	30·5	9262	10HA/11115
15	Uniradio 4	3211	Telcon 1 on ACP	3214	PL4 on T.3686	116	9263	10HA/11116
16	Duradio 11	3225	PL5 on T.3686	3221	PL1 on MU.28	129	9264	10HA/11117

Note . . .

R.3684 = receiver Type R.3684; T.3686 = transmitter Type T.3686;
M.239 = modulator Type 239; A.3687 = amplifier Type A.3687;
MU.28 = matching unit Type 28; JB367 = junction box Type 367;
SU.271 = switch unit Type 271; ACP = aerial connector panel

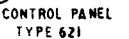


Fig.7

SECTION 6

OPERATION AND SETTING UP

Chapter I

OPERATION

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	Para.		Para.
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Transmitting room equipment	5	Receiver	
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General	7	Aerial and feeder system	15
Lighting and heating	8	Switching on radar	16
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SWITCHING ON ELECTRICAL SUPPLIES

General

1. Before the equipment in either of the transmitter wells can be operated the supplies to them must be switched on, both externally to the well and at the well switchboards.

Remote well (radar Type 7 Mk. 3)

General

2. The electrical supplies for the complete well are brought into a three-phase switchboard in the well machine room. To switch the well on,

- (1) Close the MAINS INCOMING circuit breaker on this switchboard (second from left on top row of switchboard).
- (2) Close the switches feeding various circuits in well as desired. These are:—
 - (a) MAINS TO IFF PLINTH (1-phase)
 - (b) TX ROOM SWITCHBOARD (2-phase)
 - (c) WARD-LEONARD TURNING GEAR (3-phase)
 - (d) FAN UNIT (1-phase)
 - (e) AMPLIDYNE MOTOR (3-phase)
 - (f) Distribution box feeding rack assemblies (1-phase).

Note . . .

The fan unit supplies air cooling to the rack assemblies. It will not start, even when the appropriate breaker is closed, until the rectifier unit 17 in the rack assembly 318 is switched on.

Lighting and heating

3. The lighting and heating circuits are fed from the switchboard in the transmitter compartment. To bring these circuits into operation:—

- (1) Close the MAINS INCOMING and TX ROOM SWITCHBOARD switches on the 3-phase switchboard in the well machine room.
- (2) Close the HEAT & LIGHT switch on the switchboard in the transmitter well.

- (3) The lights are then controlled by switches by the various doors and entrance hatches. The heaters are thermostatically controlled and do not require further switching on.

- (4) The capacity switch cubicle heating and lighting circuits are supplied separately via a switch (CAP. SWITCH CUBICLE), on the transmitter room switchboard. To switch on the cubicle circuits, this should be closed. The heater is thermostatically controlled while the light is controlled by a switch inside the door.

Apparatus room equipment

4. Besides switching on the supplies to the individual units in the rack assemblies at the switchboard in the machine room, the switches on the individual units must be closed. Setting up instructions for the rack assemblies are given in AIR PUBLICATIONS 2527E and H.

Transmitting room equipment

5. Switching on the transmitters and other apparatus is covered in subsequent paragraphs, while setting-up of the individual units is dealt with in Chap. 2.

6. To obtain supplies for the individual units close the switches on the transmitter well switchboard as necessary. These are:—

- (1) HEATING & LIGHTING
- (2) CAP. SWITCH CUBICLE
- (3) FAN (2)
- (4) FAN (1)
- (5) TRANSMITTER (2)
- (6) TRANSMITTER (1)
- (7) Distribution box (receivers 1 and 2, signal generator (noise) and phasing unit).

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Local well (radar Type 7 Mk. 2)

General

7. The supplies to the well are all brought into a single phase switchboard in the well. To switch the well ON:—

- (1) Close the MAINS INCOMING circuit breaker on the switchboard.
- (2) Close the switches feeding the various circuits in well, as desired. These are:—
 - (a) HEATING & LIGHTING
 - (b) CAP. SWITCH CUBICLE
 - (c) FAN 2
 - (d) FAN 1
 - (e) TRANSMITTER 2
 - (f) TRANSMITTER 1
 - (g) Distribution box (receivers 1 and 2 signal generator, noise, phasing unit, selsyns).

Lighting and heating

8. The lighting and heating supplies to the well come from one switch on the well switchboard. To get the circuits working:—

- (1) Close the MAINS INCOMING, and HEATING & LIGHTING switches on the switchboard.
- (2) The heaters are now thermostatically controlled and do not require further switching on. The lighting is controlled by a switch next to the entrance hatch.
- (3) The capacity switch cubicle lighting and heating circuits are supplied separately via a switch (CAP. SWITCH CUBICLE) on the transmitter room switchboard. To switch on the cubicle circuits, this should be closed. The heater in the cubicle is thermostatically controlled while the light in the cubicle is controlled by a switch inside the cubicle door.

TURNING GEAR

General

9. The starting of the Ward-Leonard turning gear, the capacity switch alternator and, indirectly, the capacity switch, are controlled from the control unit 618 in the radar office (Mk. 2 installations) or apparatus room (Mk. 3 installations).

Starting the aerial

10. The Ward-Leonard generator is started by pressing the button labelled START on this panel, when the starter panel will automatically start the generator set. When the machine has run up to speed (i.e. about 10 seconds after the START button is pressed) the RAISE button should be pressed and held in until the desired aerial r.p.m. has been reached. It may be necessary to make slight adjustments to the aerial speed by means of the RAISE and LOWER speed buttons until the aerial is turning at the exact speed desired.

Capacity switch

11. The starting of the Ward-Leonard set will automatically start the capacity switch alternator and, if the appropriate switches on the DC panel and capacity switch control panel are closed, the capacity switch. These switches are:—

(1) The CAPACITY SWITCH MOTOR SUPPLY switch on the DC panel

(2) The INPUT to CAP SW MOTOR switch on the control panel (capacity switch)

(3) The DC MAINS switch on the control panel (capacity switch).

The speed of the capacity switch controls the p.r.f. of the transmitter and is controlled by a control on the meter panel (PRF) 871. It should be remembered that a three-phase synchronous motor, the type which is used to drive the capacity switch, will continue to run at normal speed even if one phase of the supply is interrupted due to a blown fuse or a fault in the alternator. Under these conditions the motor will be rather noisier than usual and the windings may be dangerously overheated. For this reason it is recommended that checks to ensure that the motor is running with all phases live are made whenever the capacity switch alternator is started.

12. The speed of the capacity switch should be set accurately to 250 c/s by adjusting the control on the panel, meter (PRF) 871.

Stopping the aerial

13. To stop the aerial rotating, press the LOWER button on the control unit 618 and hold it in until the meter reads zero r.p.m. The aerial may "inch" in this condition, so if it is desired to stop it altogether open the safety switch outside the well. If the STOP button on the control unit is pressed it will stop the Ward-Leonard set which will also stop the capacity switch alternator and the capacity switch. If this is done the transmitter must first be switched off.

Note . . .

When the capacity switch is switched off the master trigger unit in the radar office will change over to synchronization from the station 500 c/s supply.

RADAR EQUIPMENT

Receiver

Switching on

14. Before the receiver can be switched on, the appropriate switch on the transmitter well switchboard should be closed. The receiver is switched on by opening the front door of the amplifier case and closing the switch on the power unit Type 866 inside the case, at the top. Allow a few minutes for the receiver to warm up and then check the HT current taken by the RF amplifier and the IF amplifier by putting the meter switch to position 3 (reading 1.5 approximately) and position 2 (reading 2.5 approximately).

Aerial and feeder system

15. There are no operational adjustments on the aerial system apart from the setting of the spark gaps on the TR unit. To set the gaps, screw them in until they touch, note the dial readings, then screw them out to increase the dial reading by 10 divisions. This will set the gaps at 0.01 in., each division of the dial being equivalent to 0.001 in. During operation the gaps wear and should be re-set when the gap reaches 0.015 in. When operating at full power it is advisable to check gaps every six to eight hours, otherwise gaps should be re-set daily.

Switching on radar**16.** To start the Type 7:—

- (1) Press the START button on the control unit (training) Type 618 in the radar office or well.
- (2) Wait at least 10 seconds for the Ward-Leonard generator set to run up to speed.
- (3) Press RAISE button and hold in until r.p.m. indicator shows that aerial is turning at approximately the correct speed. It will probably be necessary to make slight adjustment with the RAISE and LOWER buttons to get the aerial turning at exactly the correct speed.
- (4) Adjust control on panel, meter (PRF), Type 871 until p.r.f. meter indicates correct p.r.f.
- (5) Press transmitter ON button on the control unit Type 618; the transmitter will come on after approximately 4 to 5 minutes.
- (6) Check by monitoring receiver output that equipment is operating satisfactorily.

Monitoring of waveforms external to transmitter

17. The transmitter monitors can be used to monitor external waveforms at either 45 Mc/s or

video frequency. The video monitoring facility is not normally used in radar Type 7 although the input connection is available at SK11 on the back of the transmitter. The 45 Mc/s monitoring facility is used for monitoring the following waveforms:—

- (1) The outputs of receivers No. 1 and 2 (both Mk. 2 and Mk. 3 installations).
- (2) The output of amplifier Type A.3719 (Mk. 3 installation only).

18. In the Mk. 3 installation, a coaxial cable runs from the monitor output of the amplifier Type A.3719 to the control panel (capacity switch) 869 and via the transmitter changeover switch to two cables which go to the transmitters where they normally plugged into the 45 Mc/s monitoring input sockets (SK7). Thus the 45 Mc/s input normally displays the output of the amplifier Type A.3719.

19. Coaxial cables run from the receiver position to the two transmitters where they are plugged into terminated sockets (SK14), the working receiver being normally connected to the working transmitter. To display the receiver output the leads to SK7 and 14 must be interchanged.

Chapter 2

SETTING UP

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Transmitter

Preliminaries

1. It is advisable before starting to adjust the transmitter to give the individual units a quick visual examination to check that all connectors are correctly seated, valve top caps in position, etc.

Tuning

2. There are four separate adjustments on the oscillator. These are:—

- (1) Position of shorting bridge on anode line.
- (2) Position of shorting bridge on cathode line.
- (3) Length of coupling line.
- (4) Position of load tapping point on coupling line.

3. Open the door of the oscillator section and open the anode and cathode compartments. From the calibration chart supplied with the transmitter obtain the setting for the anode and cathode lechers and the stop setting for the inner trombone assembly. Set the anode lechers, cathode lechers and trombone to their correct setting and check that the load taps on the coupling are at 8-9½.

Note . . .

The coupling line has two adjustments, one coarse and the other fine. The coarse adjustment is made by slackening a screw which passes through a block on the lower end of the coupling line. This screw unclamps a spring-loaded ball catch which engages in one of five countersinks in a vertical rod attached to the incremental tuning mechanism. The adjustment is to unclamp the ball catch, reposition the coupling line so that the ball catch engages with the

appropriate countersink and then to tighten up the screw. The control on the front panel INCREMENTAL TUNING is the fine control and should be set so that the reading of the scale on the trombone is correct. If two stop-positions are given, the one which gives the most control around the desired frequency should be chosen.

4. Close the anode and cathode compartments, close the oscillator door, and connect the dummy load (RF) Type 29 across the feeder at some convenient point, and fix two shorting bars across the feeder at $\lambda/4$ and $\lambda/2$ away from the point of connection of the dummy load on the opposite side of the transmitter to isolate the rest of the feeder network. Connect a 230V 50 c/s supply to the dummy load and switch on. Switch on the transmitter and, while waiting for it to run up, switch on the wavemeter Type W.1649 which should be in the plinth of a nearby radar head and **NOT** in the well. Allow 15 minutes for the equipment to warm up, then set the wavemeter Type W.1649 to the station operating frequency using a suitable source of standard signals (such as the test set Type 404). Set the indicator, electrical, Type 105 (which forms part of the dummy load) to zero at the same time.

5. Run the transmitter up to an HT potential of 5kV and check that the main HT current is between 150 and 250 mA and that the transmitter is operating satisfactorily. Rotate the INCREMENTAL FREQUENCY control until the dummy load indicator reads a maximum and measure the frequency at which the transmitter is operating, by means of the wavemeter. If the frequency is outside the

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permitted tolerance, note the power reading on the dummy load and adjust the INCREMENTAL TUNING control until the desired frequency is obtained. If the power output at this frequency is practically the same as that previously obtained the transmitter can be left set up in this condition, but if the power output falls appreciably the anode and cathode lecher settings should be altered slightly and the transmitter again tuned for maximum output and the frequency measured.

6. The amount by which the anode and cathode setting must be changed can be easily determined from an inspection of the calibration chart, knowing the frequency change required.

7. When carrying out this tuning arcing may occur before the transmitter reaches full HT. If so, increase the load tap setting by $\frac{1}{2}$ or 1 division at a time, retuning as necessary until a coupling setting is reached at which it is just possible to run the transmitter at full HT without arcing. The final setting of the load taps is $\frac{1}{2}$ to 1 division past this point and is normally between $8\frac{1}{2}$ and 9. The maximum HT setting for the transmitter is 7 kV.

8. Repeat the tuning procedure on the standby transmitter.

Receiver Tuning

9. After switching on the receiver as in Chap. 1, allow a few minutes for the receiver to warm up, then tune the receiver as follows:—

- (1) Set a wavemeter Type W.1649 to the station operating frequency and then set the signal generator Type CT53 to the correct frequency.
- (2) Connect one output of the amplifier to a test set 4341 switched to DET via an attenuator Type 113 set to $12\frac{1}{2}$ dB, and connect a multi-meter Type 1 (Avometer model 8) set to the 50 μ A DC range to the terminals on the test set. Ensure that the other output of the amplifier is terminated in 70 ohms.
- (3) Set the four tuning dials to the approximately correct setting as given by the calibration chart on the amplifier cover.
- (4) Inject the signal generator output into the RF amplifier and adjust the four controls on the RF unit to give maximum detector current.
- (5) The amplifier is now ready for use.

Checking noise factor

10. The receiver noise factor should be checked regularly, using the signal generator (noise) Type 1, supplied. The method of operation is as follows:—

- (1) Connect one output of the amplifier to a 70-ohm load and the other to the test set 4341, via an attenuator Type 113 set to $12\frac{1}{2}$ dB.
- (2) Tune the receiver as in para. 9.
- (3) Replace the signal generator by the noise generator, switch the switch on the test set to 0 dB, disconnect the testmeter and connect the output of the test set to SK7 on the transmitter (Rx monitor output). Switch the transmitter meter to read 2ND DET. CURRENT.

- (4) With the noise generator switched on, but with its RANGE switch at OFF, adjust the gain control on the transmitter trigger unit until the meter on the transmitter shows a suitable reading.
- (5) Switch the noise generator RANGE switch on and the test set 4341 to 3 dB and adjust the noise generator output to give the same meter reading.

11. The reading of the meter on the noise generator gives the noise factor.

Note . . .

The results obtained from this test, while providing a good day-to-day check of the receiver, may differ if a different amplifying unit (IF) Type 301 is used. It is recommended that the same combination of transmitter and receiver should always be used; if this is done then the test is a good guide to receiver performance and deterioration. A more accurate method of determining noise factor is given in Part 2, Chap. 3.

12. When carrying out tuning or when measuring noise factor it is necessary to switch on the transmitter but to prevent the HT coming on. This can most conveniently be done by removing the AC fuses on the control unit Type 616. When the transmitter is switched on, the auxiliary units will come on although the main HT will not. The transmitter should not run in this condition for more than 15 minutes. Replace the fuses when the tests are completed.

Changing transmitter and receivers

13. To select a particular transmitter:—

- (1) Switch on power to it at the well AC switch-board.
- (2) Connect the synchronizing and control circuits to it by putting the TRANSMITTER CHANGEOVER switch on the control panel (capacity switch) to the appropriate position.
- (3) Change over shorting bar on transverse well feeder to isolate transmitter not in use. This is done by placing the shorting bar across the feeder at a point $\lambda/4$ from the junction of the transverse and TR switch feeders. The point is marked by pips in the feeder.
- (4) Switch on the transmitter at the control unit (training) Type 618 in the radar office (Mk. 2 installations) or the well apparatus room (Mk. 3 installations).

14. There is no necessity to change receivers when changing transmitters but the change in transmitters will mean that:—

- (1) If the same receiver is kept in use, the 45 Mc/s monitor leads to the transmitter must be changed over at the receivers (SK4).
- (2) If the other receiver is used, the monitor leads need not be touched but the receiver input and outputs must be changed over from one receiver to the other. The lead from the TR switch to the receiver input feeder is changed over at the junction box near the TR switch. The output lead (SK3) is disconnected from one receiver and plugged into the other.

Remember that the direction of rotation of the capacity switch rotor is counter-clockwise although the direction of the switching action is clockwise.

- (6) When this adjustment is correct, first tighten up the screw in the side, then the bolts, and replace the inspection cover.

18. Carry out the station setting up procedure in accordance with the relevant station specification and then re-check that the capacity switch rotor still appears opposite the top aerial plates, stroboscopically, when the transmitter fires. If not, re-adjust the capacity switch end plate.

19. When the equipment is correctly set up the various units in the well should be left switched on and the transmitter controlled from the radar office.

Radar Type 7 Mk. 3

20. Before setting-up the capacity switch, the master trigger units in the well and the radar office should be set up. When this has been done the capacity switch is set up, as follows:—

- (1) Remove inspection cover over “top” feeder plates (fig. 1).
- (2) Slacken the five hexagonal bolts securing the top plate of the capacity switch in place and loosen it (the joint may be eased by insertion of two holding-down bolts in the threaded holes provided for that purpose).
- (3) Connect a neon lamp to the top aerial feeder so that it flashes and its light shines on the “top” stator plates through the open inspection cover.
- (4) Start up the capacity switch and run the transmitter on a medium power (6 kV), when the stroboscopic effect of the neon flashing, the rotating capacity switch plates will appear stationary.

Note . . .

If it is impossible to choose a suitable position on the feeder for the neon, it can be connected to the feeder by a length of flexible wire and held near the capacity switch. If this is done, the transmitter should be run on lower power (4kV).

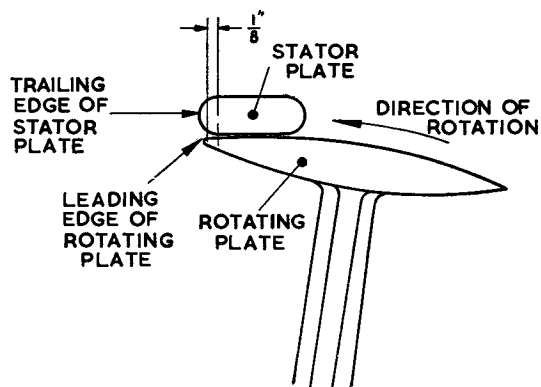


Fig. 2. Position of capacity switch plates

(A.L.9, July 56)

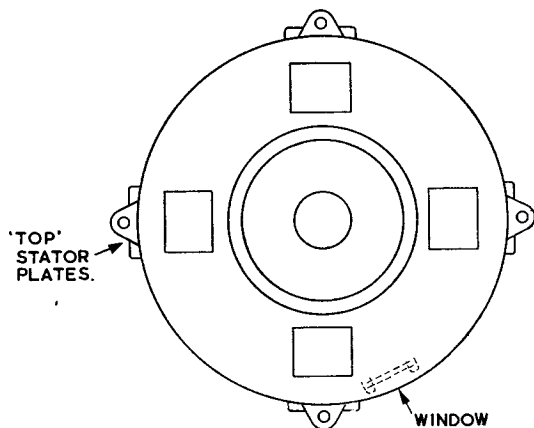


Fig. 1. Location of “top” stator plates

15. If the receiver is changed over and not the transmitter, three leads have to be changed over, the input and output and monitor output leads. When this has been done the power to the selected receiver should be switched on and that to the other receiver switched off.

Setting up capacity switch

16. The setting up of the capacity switch and instant of transmitter firing is covered in detail in the station specification and is only included here, for information.

Radar Type 7 Mk. 2

17. Before setting up the capacity switch, the master trigger unit should be set up. When this has been done the capacity switch is set up, as follows:—

- (1) Remove inspection cover over “top” feeder plates (fig. 1).
- (2) Slacken the small screw in the side of the top plate and the five hexagonal bolts securing the top plate of the capacity switch in place and loosen it (the joint may be eased by insertion of two of the holding-down bolts in the threaded holes provided for that purpose).
- (3) Connect a neon lamp to the “top” aerial feeder so that it flashes and its light shines on the “top” stator plates through the open inspection cover.
- (4) Start up the capacity switch and run the transmitter on medium power (6kV) when by the stroboscopic effect of the neon flashing, the rotating capacity switch plates will appear stationary.

Note . . .

If it is possible to choose a suitable position on the feeder for the neon, it can be connected to the feeder by a length of flexible wire and held near the capacity switch. If this is done, the transmitter should be run on lower power (4kV).

- (5) Adjust the angular position of the end plate of the capacity switch until the leading edge of the rotating capacity switch plate is level with the front of the stator plates (fig. 2).

- (5) Adjust the angular position of the end plate of the capacity switch until the leading edge of the rotating capacity switch plate is level with the front of the stator plates (*fig. 2*). Remember that the direction of rotation of the capacity switch rotor is counter-clockwise although the direction of the switching action is clockwise.
- (6) When this adjustment is correct, first tighten-up the bolts, and then replace the inspection cover.

21. Carry out the station setting-up procedure in accordance with the relevant technical manual and then re-check that the capacity switch rotor still appears opposite the top aerial plates, stroboscopically, when the transmitter fires. If not, re-adjust the capacity switch end plate.

22. When the equipment is working correctly the OFF button on the control unit should be pressed to close down the station. All switches in the well should be left on. Then the transmitter can be switched on by pressing the ON button on the control unit.

Testing standby transmitter

23. The standby transmitter can be run for test purposes while the other transmitter is operating as the well power supply can take the extra load. If this is done certain conditions must be observed. These are:—

- (1) The transmitter must be run in synchronism with the one in use. This can be achieved by,
 - (a) Running the standby transmitter trigger from MSW and adjusting the PHASING control on the trigger unit until the standby transmitter is firing at the same instant as the operating transmitter.
 - (b) If this method is unsatisfactory the sync input at the back of the transmitter (SK8) should be connected to SK12 on the back of the transmitter in use and the standby transmitter run on EXT.
 - (c) On Mk. 3 installations it is preferable to run the transmitter from the test delay unit on the master trigger unit in the well.
- (2) It is preferable that the transmitter should be operated with the modulator test load substituted for the RF oscillator.
- (3) If necessary, the transmitter can be operated with the RF oscillator connected into the RF test load. The test load should be laid onto its side on top of the transmitter and connected to the well feeder network by means of the rods provided, the transmitter and the test load being isolated from the rest of the feeder system by two shorting bars placed $\lambda/4$ and $\lambda/2$ away from the point on the feeder where the test load is connected on the side of the feeder **away** from the transmitter. It is preferable, however, that any tests carried out on the RF oscillator portion such as frequency, power output, etc. be made while the other transmitter is not operating. This will prevent incorrect results due to pick-up or other causes from the transmitter not under test.

- (4) The control circuits of the transmitters are such that the transmitter not selected at the control panel Type 869 is controlled by the ON and OFF buttons on its front panel.

Tuning system for optimum performance

24. A considerable improvement in the operational performance of radars Type 7 can be effected using the existing standard test equipment in conjunction with a simple half-wave horizontal dipole, which can be made up on site using copper tube $\frac{1}{2}$ in. external diameter, $\frac{1}{8}$ in. internal diameter, cut into two equal lengths of $14\frac{9}{16}$ in., held by a polystyrene insulator mounted on a wooden stand 9 feet above the ground and placed in the centre of the station operational sector at a distance of approximately 75 yards in front of the radar Type 7 aerial. The dipole is connected by a suitable length of Uniradio 32 or 70 coaxial cable to test equipment in the plinth of a nearby radar aerial head, which must be in a direction from the radar Type 7 approximately at right angles to that of the dipole. In addition to the dipole, the standard test equipment required comprises the wavemeter Type W.1649, the signal generator Type CT73, the test set Type 4341, a multimeter Type 1 and a terminating unit Type 34.

25. The procedure is as follows:—

- (1) Set the turning gear SAFETY switch to SAFE and turn the aerial by hand until it points in the direction of the dipole. Lock the aerial in this position.
- (2) Ensure that the capacity switch is OFF and set it by hand so that the TOP aerial is coupled to the transmitter.
- (3) Switch ON the transmitter Type T.3705 (with the TRIGGER switch SW3 on the trigger unit Type 2 set to 250 c/s for internal synchronizing), the amplifier Type A3694, the wavemeter Type W.1649 and the signal generator Type CT.53 and allow at least 15 minutes for warming up before commencing the tuning operation. Set the RF OUTPUT control on the signal generator to minimum.
- (4) Disconnect the normal coaxial cables from the output sockets SK3 and SK4 on the amplifier Type A3694 and connect instead a terminating unit Type 34 to SK3 and the input of the test set Type 4341, with the rotary selector switch set to DET. to SK4. Connect the multimeter Type 1, set to the 50 μ A DC range, across the output terminals of the test set.
- (5) Connect the input socket of the wavemeter via the attenuator Type 113 (set to 25 dB) to the coaxial cable leading to the dipole and use the wavemeter to check that the transmitter is operating on the correct frequency, giving, if necessary, telephonic instructions for its correction by adjustment of the INCREMENTAL TUNING CONTROL on the front of the transmitter. After making any adjustments that may be required, leave the wavemeter tuned to the transmitter.
- (6) Switch OFF the transmitter.

- (7) Connect the ATTENUATED RF OUTPUT socket on the signal generator to the coaxial cable leading to the dipole. Set the ATTENUATOR controls to give a suitable output (usually maximum).

Note . . .

These controls must not subsequently be touched.

- (8) Connect the FULL RF OUTPUT socket on the signal generator via the attenuator unit Type 113 (set to 12.5 dB) to the input socket on the wavemeter, the tuning controls of which must not be altered. Set the RF OUTPUT control to give the normal reading on the built-in meter and tune the signal generator (which must be set for INTERNAL SINE WAVE operation) to the wavemeter, that is, to the same frequency as the transmitter.
- (9) Tune the controls on the amplifying unit Type 299, starting with the local oscillator tuning control C4, for maximum deflection on the multimeter. Repeat this operation several times.

Note . . .

It is assumed that the amplifier Type A3691 is correctly aligned and that the GAIN control on the power unit Type 886 is set in accordance with the procedure described in Part 2, Chap. 3.

- (10) Disconnect all test equipment and replace the normal coaxial cables in sockets SK3 and SK4 on the amplifier Type A3694.

26. The above procedure ensures that the receiver is tuned under operational conditions, that is, when connected to the aerial, and that, within the limits of accuracy of the existing test equipment, the receiver is tuned to the operating frequency of the transmitter.

Aerial array and feeder system

27. The aerial arrays and feeder system are set-up on installation and all adjustments soldered and painted. The feeder system should remain in adjustment over a considerable period, but a regular check of the standing wave ratio should be made as in para. 29 to 32; if the SWR is worse than that specified, a maintenance party should be called in to carry out readjustments to the aerial system. In no circumstances should personnel on site attempt to make any adjustments to the aerial and feeder system, because, due to the complexity of the aerial system, the setting-up procedure is very complicated and may take several days to complete. When working on the aerial framework, care should be taken not to subject any part of the aerial or feeder system to any strain as this may have the effect of adversely affecting the SWR.

Checking of feeder standing-wave ratio

28. To check the standing-wave ratio of the aerial system the following items of test equipment are required:—

- (1) Test set Type 404
- (2) Test kit Type 29A.

29. Place the shorting bar on the transverse feeder to isolate one of the transmitters. Open the RF compartment door of the other transmitter

and connect the test set Type 404 to the end of the feeder at the rear of the compartment. Switch on the test set Type 404, operating it on crystal control, at the required operating frequency.

30. Disconnect the T & R unit (switch unit Type 405) from the well feeder network by slackening the 6 B.A. screws which clamp the wires forming the resonant lines to the blocks on the main feeders and pulling the four wires so that they are disconnected at the feeder end.

31. Using the standing-wave indicator which forms part of the test kit Type 29A, check the standing-wave ratio on the vertical feeder between the junction of the well feeders and the base of the column. If this is worse than 0.8, the services of a maintenance party should be obtained, to readjust the aerial and feeder system.

Note . . .

Standing-wave ratio is defined as the ratio of the voltage at a minimum to the voltage at a maximum (Air Publication 2867A).

32. When the standing-wave measurements have been completed, reconnect the four wires in the T & R unit, tensioning them with a pair of pliers before clamping them in position.

Setting up spark gaps

33. The spark gaps, which are of the open type, are adjustable and should be set to 0.01 in. As the gap electrodes wear down, the gap should be reset. The gap control knobs are calibrated to facilitate this.

Turning gear

34. The operation of the turning gear is described in Chap. 1 of this section. The setting-up and initial switching on of the turning gear is carried out as follows:—

- (1) Close the WARD-LEONARD TURNING GEAR switch on the main AC switchboard, start the Ward-Leonard generating set by pressing the START button on the control unit Type 618 and check the meter readings on the DC control board, both with the aerial at rest and with it rotating. Typical readings taken on an equipment are given in TABLE 1.
- (2) When the system is operating satisfactorily, stop the aerial by pressing the LOWER speed button until the aerial is stationary.

Note . . .

Before the aerial system can rotate, the safety switch outside the well must be closed.

TABLE 1
Typical Ward-Leonard meter readings

Speed MG	Set Load	Exciter Output		Generator		
		Volts	Amps.	D.C. Volts	Amps. Field	Amps
0	9.3	230	6.0	5.0	2.0	—
6	18	230	7.15	235	11	1.4

Note . . .

These readings are taken with a wind speed, at ground level, of 15 m.p.h.

(A.L.9, July 56)

PART 2

TECHNICAL INFORMATION

Chapter 1
WELL AND AERIAL

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WELL AND ACCESSORIES

Control panel (capacity switch) 869

1. To obtain access to the capacity switch control panel:—

- (1) Remove two Jones plugs at the right-hand side.
- (2) Loosen two captive screws at the top of the front panel.
- (3) Lower the door until it rests on the stops. DO NOT LET IT FALL, or it might damage the stops or its hinges.

2. With the door open, the Jones plugs can be inserted and the unit operated with full access to internal components.

Warning . . .

It should be noted, however, that in this condition live mains connections are prominent on the inside of the door and care must be taken to prevent accidental contact.

Phasing unit ($\frac{1}{2}$ p.r.f.), Types 30 and 100

3. To obtain access to the phasing unit:—

- (1) Remove the two Jones plugs at the right-hand side.
- (2) Loosen two captive screws at the top of the front panel.

(3) Lower the door until it rests on the stops. DO NOT LET IT FALL.

4. With the door open, the Jones plugs can be inserted and the unit operated with full access to internal components. It should be noted, however, that in this condition, live mains connections are prominent on the inside of the door and care must be taken to prevent accidental contact (*para. 2*).

5. The phasing potentiometers in this unit are set up on installation and must not be adjusted, unless the unit, or the capacity switch, has become faulty, when, after repairs have been carried out, the potentiometers should be set up in accordance with the appropriate station specification.

AERIAL AND FEEDER SYSTEM

Aerials and feeders on aerial frame

6. Examine external feeders, behind and in front of reflector screen, and particularly all feeder joints. Remove any foreign matter between feeder lines and between transformer plates. Check nuts, bolts and screws for tightness on:—

- (1) Plates on reflector screens carrying dipole supporting arms (this can be done from behind the screen).
- (2) Supporting brackets and stubs carrying feeders.

- (3) Feeder couplings. Check for broken insulators and spacers.

Note . . .

When carrying out any work on the aerial and feeder system, care must be taken not to put any strain on any portion, as displacement of individual components from their correct positions is liable to affect the standing-wave ratio of the system and its height-finding accuracy.

Capacity switch cubicle

7. Check the rigidity of the switching network in the cubicle and the tightness of supporting brackets, etc. Examine the coupling unit and check that there is no dust or foreign matter between the plates. Check for broken insulators and spacers. The coupling unit is fitted with an

Oilite bearing, and a grease-packed ball race, and so will not require lubrication.

Note . . .

The positions of the feeders and especially the stub on the coupling unit are very critical. Extreme care must be taken not to knock or disturb the settings of any feeders or stubs in the cubicle. Do not attempt to approach near to the coupling unit unless absolutely necessary.

SWITCH UNIT (T & R) TYPE 405

Changing electrodes

8. Remove movable electrode and its holder by turning knob counter-clockwise until it can be withdrawn. Pull the used electrode from the holder (it is a force fit) and replace it with a new electrode (the shorter one of the pair 10AD/885). Approximately $\frac{7}{16}$ of an inch should protrude. Replace the complete assembly in the switch.

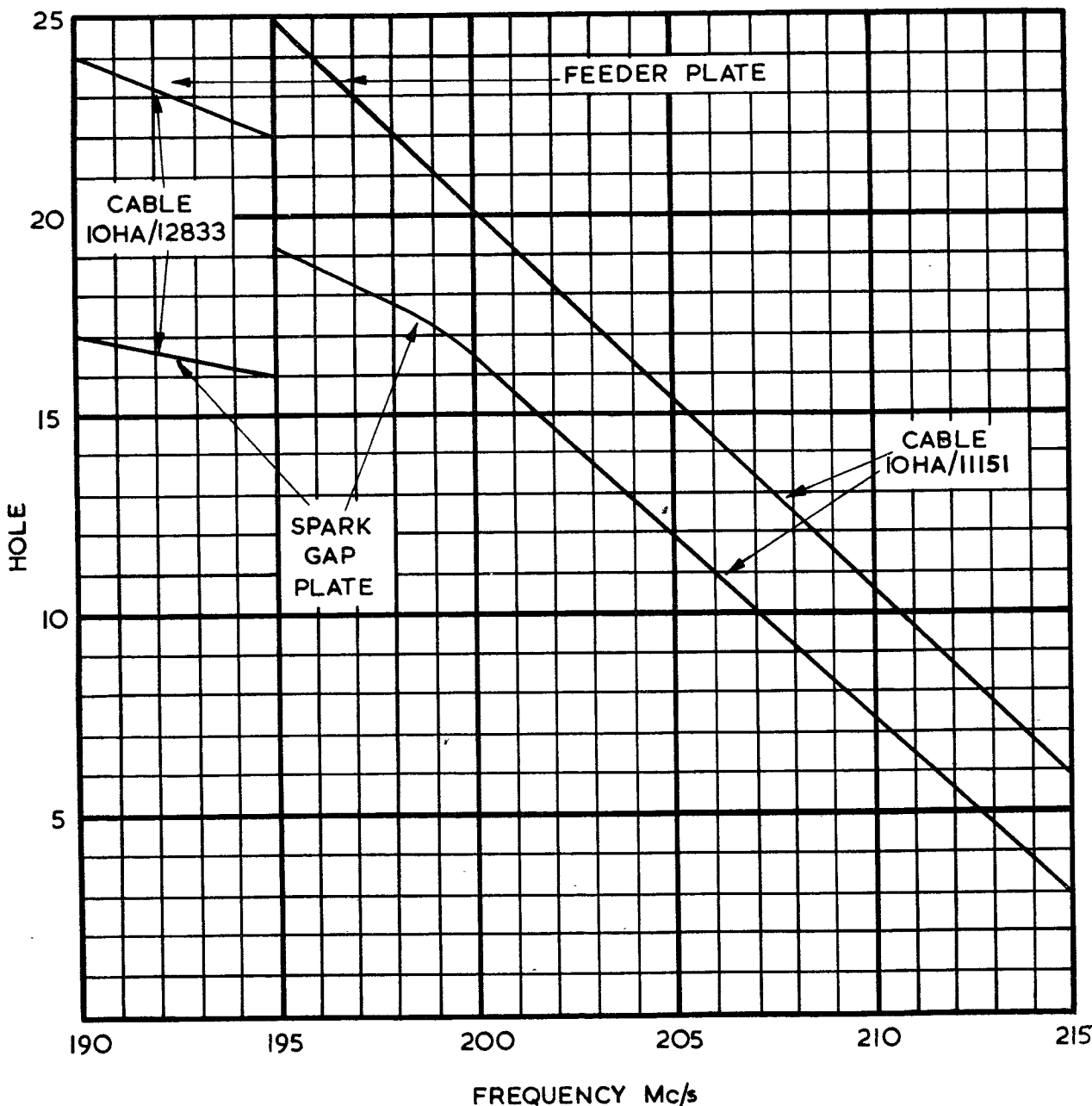


Fig. 1. Calibration curve of TR switch

Change the other electrode by slackening the clamping nut and sliding the electrode out.

Note . . .

The electrode can be removed easily, by clamping the portion which protrudes in a vice and pulling the holder off it with an unscrewing motion. The new electrode can be lightly tapped to drive it into the holder.

9. After the electrodes have been replaced, adjust until the gap is approximately centrally disposed with respect to the two wires. The electrodes should always be changed as a pair.

Changing frequency

10. The procedure for changing frequency differs depending on whether the frequency is to be changed up or down. If the frequency is to be increased this involves shortening the TR switch wires which can be done without replacing the

wires. If the frequency is to be reduced, this will mean replacing the wires, so the procedure differs. On the radar Type 7, it is unlikely to be necessary to retune the TR switch, but the procedure is applicable if it is necessary to replace the wires.

Increasing frequency

11. Remove the screws (10 in number) holding the feeder mounting plate to the support frame. Slacken the screws which clamp the phosphor bronze wires to the feeders, then slacken the bolts holding the TR switch mounting bracket and slide the whole TR switch towards the feeder mounting plate until the plate can be bolted in its new position (obtained from the calibration curve in fig. 1). Tighten the mounting bolts. Next remove the screws holding the spark gap mounting plate and slide this into its new position and bolt it there. Finally pull the four wires taut with a pair of pliers, lock the ends with the screws on the

TABLE 1
Lubrication

Item	Oil or Grease	Amount	Period	Remarks
Main drive chain	OX.320	Lightly oil	Daily	
Selsyn chain	OX.320	Lightly oil	Daily	
Selsyn drive shafts	OX.320	Lightly oil	Daily	
Capacity switch feeder terminals	MS.4	Thin film	Weekly	If arcing apparent
Isenthal regulator drive motor	OM.33	10 drops	Monthly	
Main drive gearbox	OC.338	As required	Monthly	Check level and top up
Auto-align contact pivots	OM.33	1 drop	Monthly	
Safety switch—Springs	XG.271	Lightly smear	Monthly	
Moving parts	OM.33	Lightly oil	Monthly	
Main drive jockey sprocket bearing	XG.271	2 shots	3-monthly	
Main drive gear box bearings	XG.271	1 shot per nipple	3-monthly	
Motor generator Type 81	XG.271	1 shot per nipple	3-monthly	
Capacity switch alternator	XG.271	1 shot per nipple	3-monthly	
Field rheostat gearing	XG.271	Lightly smear	3-monthly	
Aerial drive motor tachometer	OM.33	2 drops	3-monthly	
Selsyn gear trains	XG.271	Lightly smear	3-monthly	
Fan assembly Type 26	XG.271	1 shot to each nipple	3-monthly	
Aerial drive motor Type 72	XG.271	1 shot each nipple	6-monthly	
Capacity switch	XG.271	1 shot each nipple	6-monthly	
Capacity switch drive motor	XG.271	1 shot each nipple	6-monthly	
Main drive gear	OM.21 OC.338	2 gallons 2 gallons	6-monthly	Drain, flush with OM.21 and refill with OC.338
Top bearing	XG.271	2 oz. approx.	12-monthly	
Roller bearings	XG.271	3 shots per nipple	12-monthly	
Roller track	XG.271	As required	12-monthly	Lightly grease
Motor generator Type 81	} XG.271	As required	2 years	Bearings to be cleaned of old grease and recharged $\frac{2}{3}$ full
Capacity switch alternator				
Aerial drive motor				

feeder block, lock the wires at the spark gap and cut off the surplus.

Decreasing frequency

12. Remove the screws (10 in number) which hold the feeder mounting plate to the support frame. Slacken the screws which clamp the phosphor bronze wires to the various clamps and remove the movable shorting bar, then slacken the bolts holding the TR switch to the mounting bracket and slide the whole TR switch away from the feeder plate, when the wires will spring out of the holes. Locate the feeder plate in its new setting and bolt it in place. Remove the screws holding the spark gap support plate and locate this in its new position, then bolt it in place. Next, remove 10 screws holding the end plate and pull the end plate away complete with wires. Slacken the screws holding the transmitter blocker wires, pull the wires out and replace them with new wires (20 S.W.G. phosphor bronze) sufficiently long for the purpose. Next remove the two cover plates on the sides of the blocks on which SK2 and 3 are mounted, and unsolder the wires where they are connected to the sockets. In the case of SK3 it will be necessary to cut the wire instead of unsoldering it the first time the wire is changed as for convenience in manufacture the wire in the quarter wave transformer is a continuation of the wire in the TR switch. Solder new wires in position, taking care that the wire inner of the $\lambda/4$ transformer is not allowed to go slack, and re-assemble the TR switch, tensioning the wires as above.

Note . . .

In an emergency, if sufficient wire is not available, it is permissible to knot the wires and solder the join. If this is done the join must be near the low voltage ends of the wires and only one join may be used per wire.

Final tuning

13. When the switch has been correctly reassembled, switch the equipment on and adjust the movable shorting bar for maximum performance, that is, by adjusting the bar to give maximum responses from non-frequency sensitive permanent echoes.

Electrode wear

14. On full power the electrodes wear approximately 1.2 thousandths (.0012 in.) per hour. This means that on full power the gaps should be reset every four hours. However, the equipment will continue to operate but at reduced efficiency for as long as 12 hours, if it is impossible to reset the gaps before.

AERIAL FRAME AND TURNING GEAR

General

15. Details of lubrication of units of the aerial frame and turning gear are given in TABLE 1.

Gearbox (fig. 2 and 3)

16. The main drive gearbox, located at the foot of the column, is provided with a dip-stick for checking oil level, which should come up to the line on the dip-stick. Avoid over-filling. Before draining the gearbox, rotate the aerial for at least half-an-hour at full speed to warm up the oil. Then drain, refill with two gallons of flushing oil, turn for a few revolutions, drain again and refill with lubricating oil.

Chain

Driving chain tension check

17. Lock the aerial frame by means of the stay bars. Turn the motor coupling by hand until the driving chain is taut and check that the chain can just be lifted off the jockey sprocket.

Chain tension adjustments

18. There are two adjustments of chain tension:—

- (1) A coarse adjustment by mounting the jockey sprocket mounting on a slide.

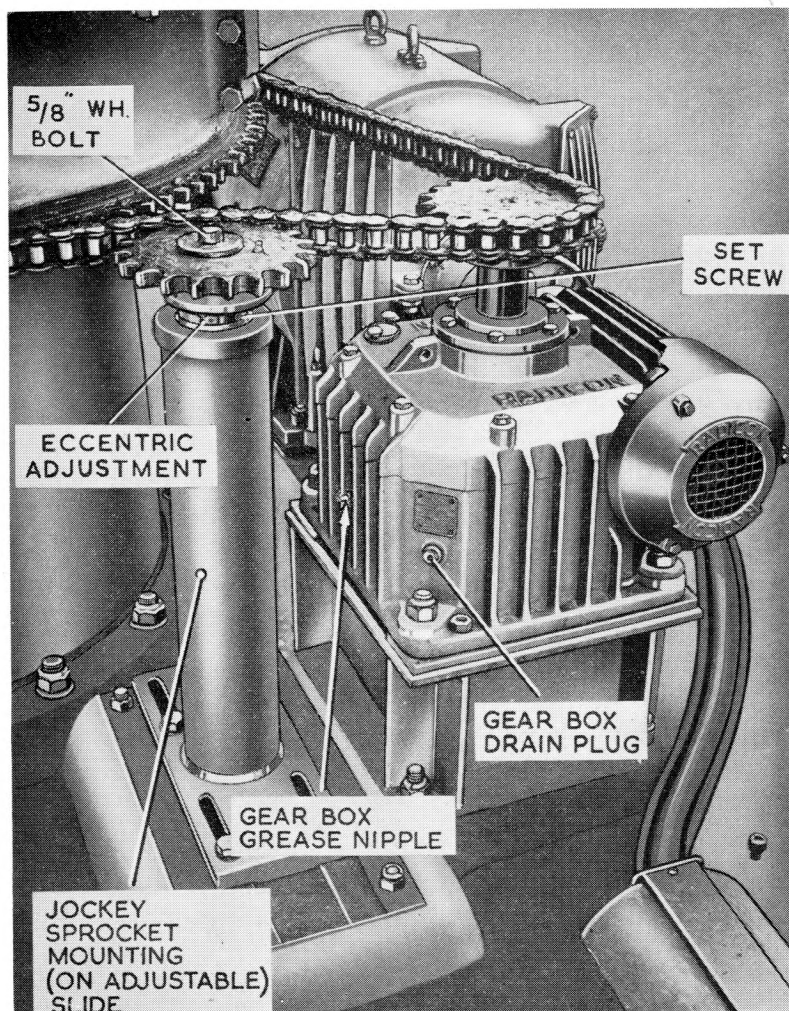


Fig. 2. Gearbox and jockey sprocket

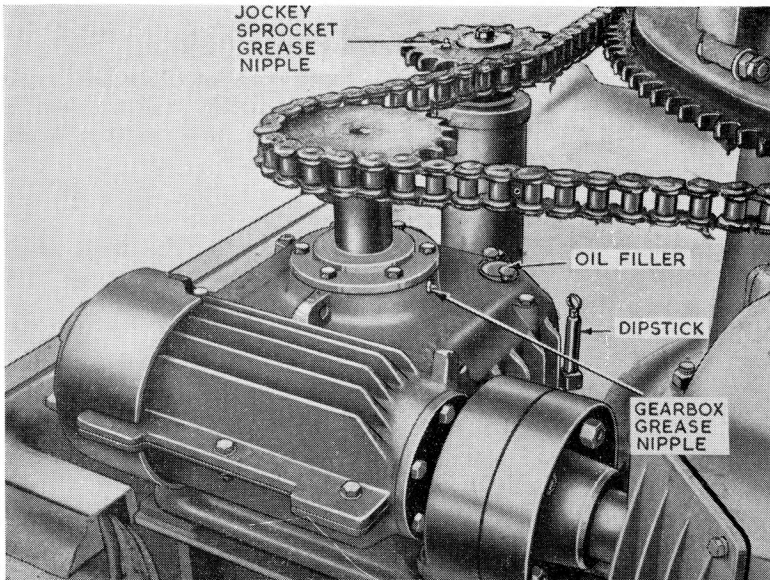


Fig. 3. Gearbox dipstick and oil filler

- (2) A fine adjustment by means of an eccentric on the underside of the jockey sprocket. This should be adjusted with a C spanner after the $\frac{3}{8}$ in. Whitworth bolt on the top and the Allen set screw in the side of the eccentric have been slackened. Re-lock after adjustment.

Chain wear

19. The main wear on this chain takes place on the upper side of the links. The chain should be examined for wear here and if any is apparent, the first opportunity should be taken to remove the chain and reverse it so that the worn portion of the links is now at the bottom.

Selsyn drive

20. The selsyn drive is very exposed and must be maintained carefully and regularly. Before fitting a new chain it should be pre-stretched by suspending it by one end and hanging a weight of approximately 400 lb. from the other for about 15 minutes.

21. The intermediate drive brackets on the selsyn drive are fitted with Oilite bearings and the shafts should be oiled every time the chain is treated.

Top bearing and slipring unit

22. When lubricating the top bearing or servicing the slipring unit, the greatest care must be taken not to disturb the feeder runs inside the capacity switch cubicle in any way.

23. Periodically the wire covers enclosing the slipring unit should be removed and the sliprings examined for even brush deposit and the brushes themselves

examined for even wear and correct pressure against the sliprings. An uneven brush deposit will indicate degraded brushes, whilst pitting or wear of the sliprings themselves will indicate the occurrence of sparking due to incorrect brush pressure.

24. Brushes are easily replaced, but should be well bedded-in, using fine glass paper (*not emery paper or cloth*). The glass paper should be held firmly against the sliprings, with the abrasive side outwards and the brush should be lowered on to it. By pulling the glasspaper in one direction only, the face of the brush should be abraded, until it exactly fits the contour of the slipring. All carbon dust should be removed from the slipring unit using a blower or a vacuum cleaner. Excessive deposit on the sliprings should be removed with carbon tetrachloride, but the thin black carbon film (the dark ring) should not be removed.

25. Pitting or scoring of sliprings should be removed by gentle abrasion with fine glass paper or a suitably shaped stone, finishing with dead smooth paper or stone.

Guide rollers

26. The guide rollers can be adjusted by slackening the nuts which hold the eccentric bearings and rotating the eccentric to move the rollers relative to the roller track. It is most important that the nuts securing the eccentric bearings should not be loosened more than is absolutely necessary.

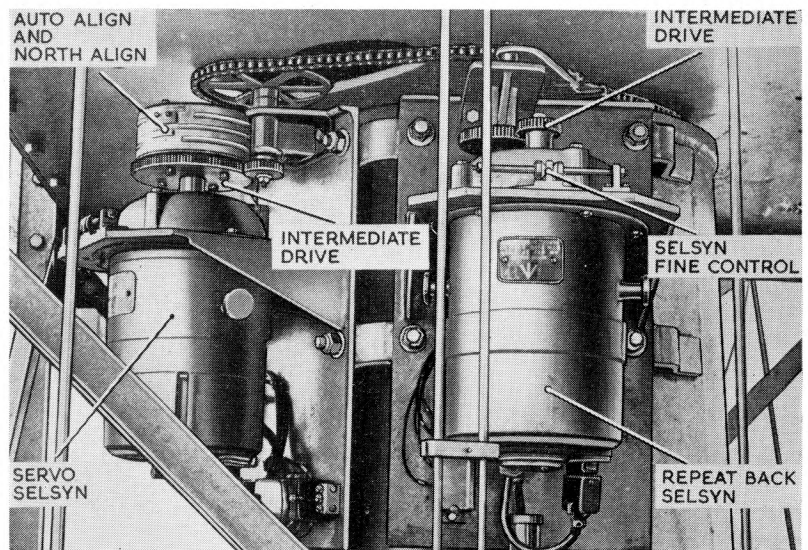


Fig. 4. Details of selsyn drive

27. The adjustment of the rollers should be checked as follows:—

- (a) Check that the column is exactly vertical, either by using a clinometer Mk. VA or by using a spirit level on the floor of the capacity switch cubicle, as described in the station test specification.
- (b) Check that with the aerial frame in such a position that there is no clearance between two pairs of rollers and the roller track on the array side of the column, the clearance between the remaining pair of rollers and the roller track should not exceed 0.005 in.

28. These checks should be made with the aerial set in at least four different positions.

Feeder rotating coupling unit

29. This unit is fitted with an Oilite bearing and a grease-packed ball bearing, and so will not require lubrication. If the unit develops bearing trouble, it should be changed.

Isenthal voltage regulator

30. The three-way switch on the front of this unit on the DC panel should be changed to the alternative ON position daily.

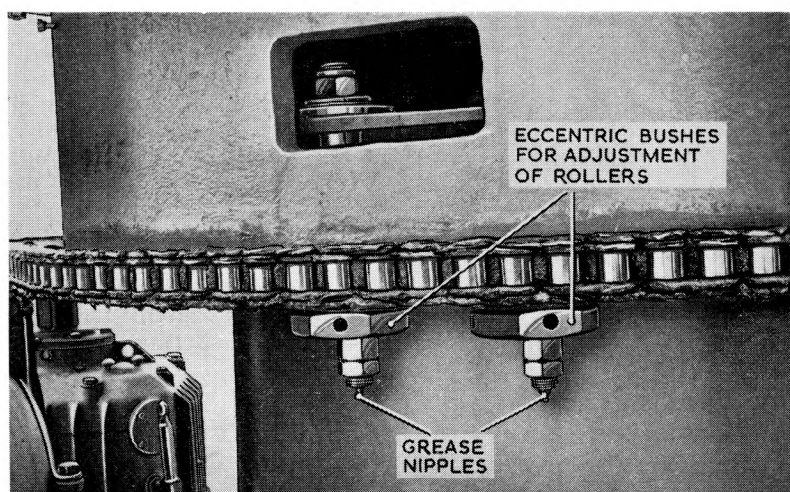


Fig. 5. Guide rollers

Chapter 2

TRANSMITTER

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Removal of main doors

1. The two front doors are hung on the cabinet by means of adjustable hinges, a screw being provided on each hinge to keep the faces of the two halves of the hinge out of contact. Inside each hinge between the top of the hinge pin and this screw is a ball bearing which takes the entire load on the hinge. This type of hinge has very little friction and is necessitated by the weight of the right-hand door assembly. The doors are readily removable, a lift of 2.25 in. being sufficient to clear the hinges. As the door is removed the ball bearings will fall out and should be replaced, when the door is refitted, by removing the bolts in the top of the hinges. When replacing, the bolts should be screwed down until the mating faces of the hinges are .062 in. apart; the bolts should then be locked with the lock nuts.

2. When the right-hand door is closed, its weight is taken by a latch and pin at the bottom of the door. This ensures that there is no strain on the bolt of the locking handle or on the interlocking mechanism. This assembly is adjusted with the door correctly hung on its hinges so that the weight of the door is shared equally between it and the hinges. The adjustment is made by a hexagon-headed eccentric bush on the bottom fixing bolt of the assembly.

Indicator lamps

3. The main indicator lamps on the transmitter are of the 230V 15W pigmy type and are mounted horizontally in standard bayonet holders which are secured to vertical hinged plates inside the front member of the frame. This frame is of channel

(A.L.I I, Dec. 56)

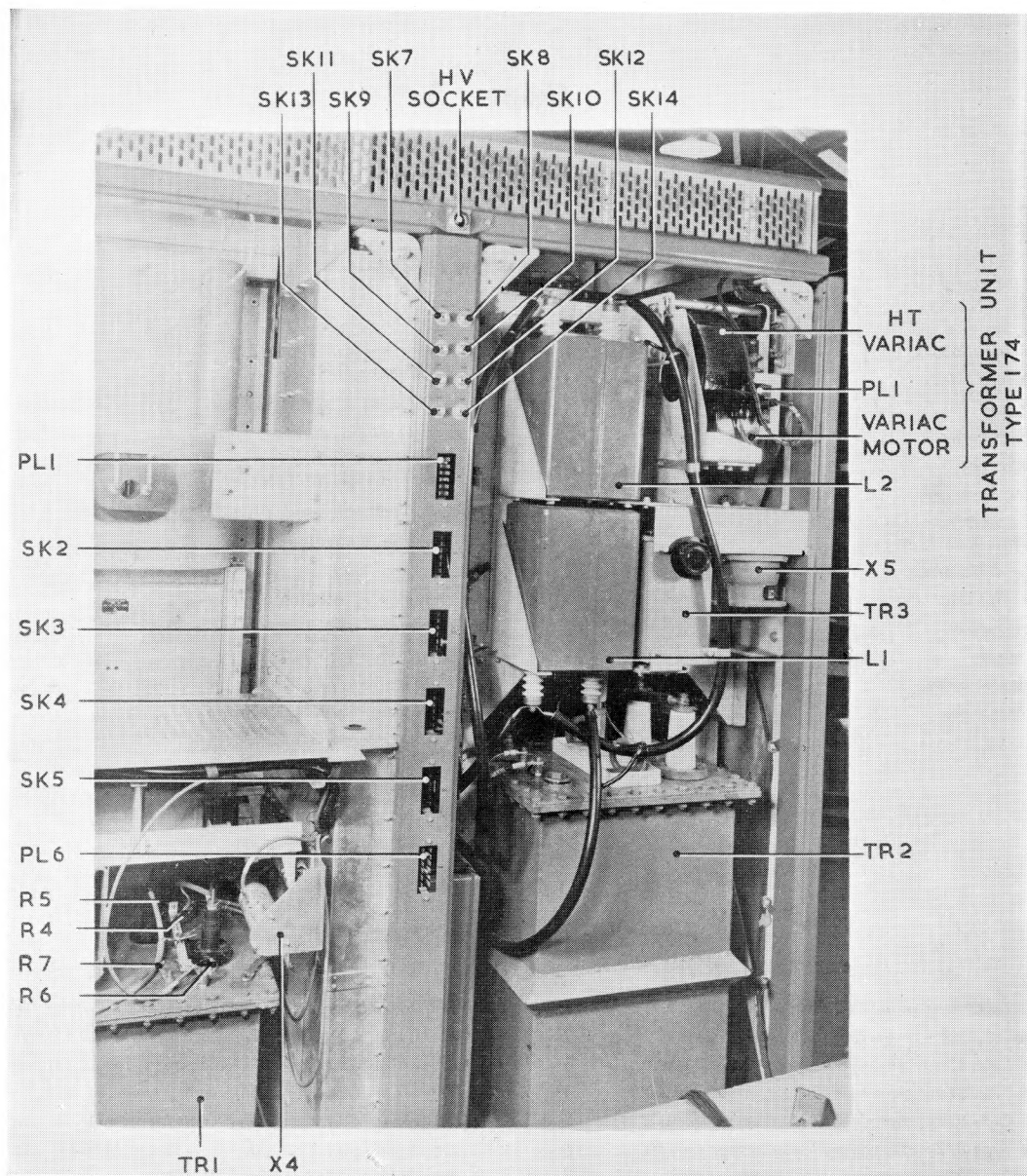


Fig. 1. Transmitter with rear panels removed

section and a small catch fitting into a notch cut on the frame holds each plate in position. When this catch is pressed the holder can be swung to the left so that the bulb can be removed. The lamps HT ON and HT UP are provided with a screening cover as they are in the RF compartment. This cover must be removed before they can be reached. When the lamp holder is swung back into position, it locks automatically.

Discharger unit

4. This is held in place by two captive bolts which screw into the front of the bottom frame and by two dowel pins on its base.

Pulse-forming network

5. The main pulse forming network (PFN) and the power unit (heaters) Type 887 are mounted on

telescopic runners so that they can be pulled forward for inspection. Before attempting to withdraw the pulse-forming network, the front cover of the power unit (heaters) should be opened by unscrewing the captive screw at the top and, then, disconnecting the Jones socket. On the right-hand side of the power unit is a wing nut which completes the heaters circuit; this should be slackened. Finally the two connections to the PFN terminals should be undone and the two catches on the ends of the runners released by turning them through 90 deg. The assembly may then be pulled forward.

Pulse transformer

6. The main pulse transformer, TR1 in *fig. 1*, is mounted in the bottom of the right-hand compartment, at the rear, on an angle frame. Holes on its rear mate with pins on the framework while the

front is held down by bolts. Extensions of the frame are bolted to the pulse transformer and can be hinged forward on to a wood block so that the pulse transformer can be slid forward and removed if necessary, after disconnecting the leads to it.

RF oscillator Type 271

7. The oscillator assembly is housed in two separate screened compartments, one above the other, screwed to a large screening plate which is secured to the door by bolts which screw into hank bushes on the door frame. The lower compartment is actually hinged to the rear of the door so that when these bolts are removed the whole oscillator assembly can be swung away from the door. Access can then be gained to the screened compartments on the front of which are mounted the conductor feeding the heater supply to the oscillator valves and the mechanical tuning drive for the coupling line.

Main EHT power supply equipment

Transformer unit Type 174

8. The transformer unit Type 174 is mounted on telescopic runners so that it can be withdrawn, if desired; it is secured by two bolts on the right-hand side. A latch holds the runners withdrawn and then the Variac assembly can be lifted off them. It is not secured to the runners but is held in position by its weight. The Variac takes up most of the space on the unit which also has a number of capacitors mounted on a vertical chassis at the front. This capacitor unit is entirely separate from the HT Variac electrically and mechanically and provides extra smoothing for certain of the auxiliary HT circuits. It can be removed as a complete sub-assembly, when servicing the Variac, by undoing and removing two fixing bolts on the right-hand side of the HT Variac unit, after disconnecting a 12-pole Jones plug. The Variac driving chain is tensioned by adjusting the position of the motor on the chassis. The motor is filled with oil Type OM13. This is done by removing the oil cap on the top and the two 6BA screws on the adjacent side, filling till the oil overflows from the screw holes, and then replacing the screws and cap. The chain is greased with a thin film of grease, low temperature, XG271. When returning the transformer unit to its normal position, the catch must be pressed down to slide the unit home.

Changing drive motor or Variac

9. To change either of these, proceed as follows. Find and remove the split link on the drive chain and remove the chain. Remove the faulty component and substitute the new one for it. Then set up the drive as follows:—

- (1) Apply an AC supply to the motor (that is, to pins 2 and 3 of PL1 of the unit) so that the motor rotates clockwise (when viewed from the sprocket end) until the limit switch stops the motor.
- (2) Turn the Variac clockwise until the distance between the stop and the side of brush carriage which will engage with this stop is 25 thou. (.025 in.). Note the position of the brush on the winding.

- (3) Put the chain on again, turning the Variac brush anti-clockwise if necessary to get correct meshing of chain. Tension the chain, if necessary, by moving motor, then check new brush position. If brush has been moved less than $\frac{1}{8}$ in. from stop, the setting-up is satisfactory, but, if not, proceed as follows:—

- (a) Remove the chain, and remove the two grub screws holding the Variac drive shaft to the Variac rotor.
- (b) Turn the sprocket and shaft through an angle of 60 deg. (that is, three teeth) with respect to the Variac rotor (this is to clear the countersinks drilled in the shaft) and refit the chain. Turn the Variac rotor back by hand until the distance between the side of the brush carriage and the stop is 25 thou. (.025 in.). Check that the drive chain runs parallel to the side plate of the Variac. Finally mark the new positions of the grub screws on the Variac drive shaft.
- (c) Remove the chain and the shaft, and drill two new countersinks on the shaft in the new position, using a $\frac{3}{32}$ in. drill.
- (d) Reassemble the shaft, grub-screws and chain taking care that the grub screws are located in the new holes. If the re-assembly is carried out correctly, the Variac brush will be just off the stop, when the chain is correctly fitted.
- (e) Finally check tension of the chain and re-adjust, if necessary.

EHT rectifier unit

10. The EHT rectifier unit Type 26 rests on runners, in the bottom left-hand compartment, which also accommodates the EHT transformer. The rectifier unit is secured at its rear by dowels on it which fit into holes in a bar fixed across the front of the EHT transformer at the bottom. The front of the unit is secured by two bolts through the runners on which it rests.

EHT transformer

11. The EHT transformer, TR2 in *fig. 1*, is similarly mounted, being held at the back by forked-tongues into which dowels, on the sides of the runners, fit. The front of the transformer is held by two special bolts through the runners. As an extra safeguard, the transformer is also clamped down by means of a special clamp between the top of its case and a member of the transmitter frame just above it. Special tools are required for removing the transformer and these are provided with the transmitter. The EHT transformer may be removed as follows:—

- (1) Remove the rectifier unit Type 26.
- (2) Disconnect all cables from transformer.
- (3) Remove special bolts and special clamps.
- (4) Remove withdrawal gear from stowage position and insert as shown in *fig. 2*.

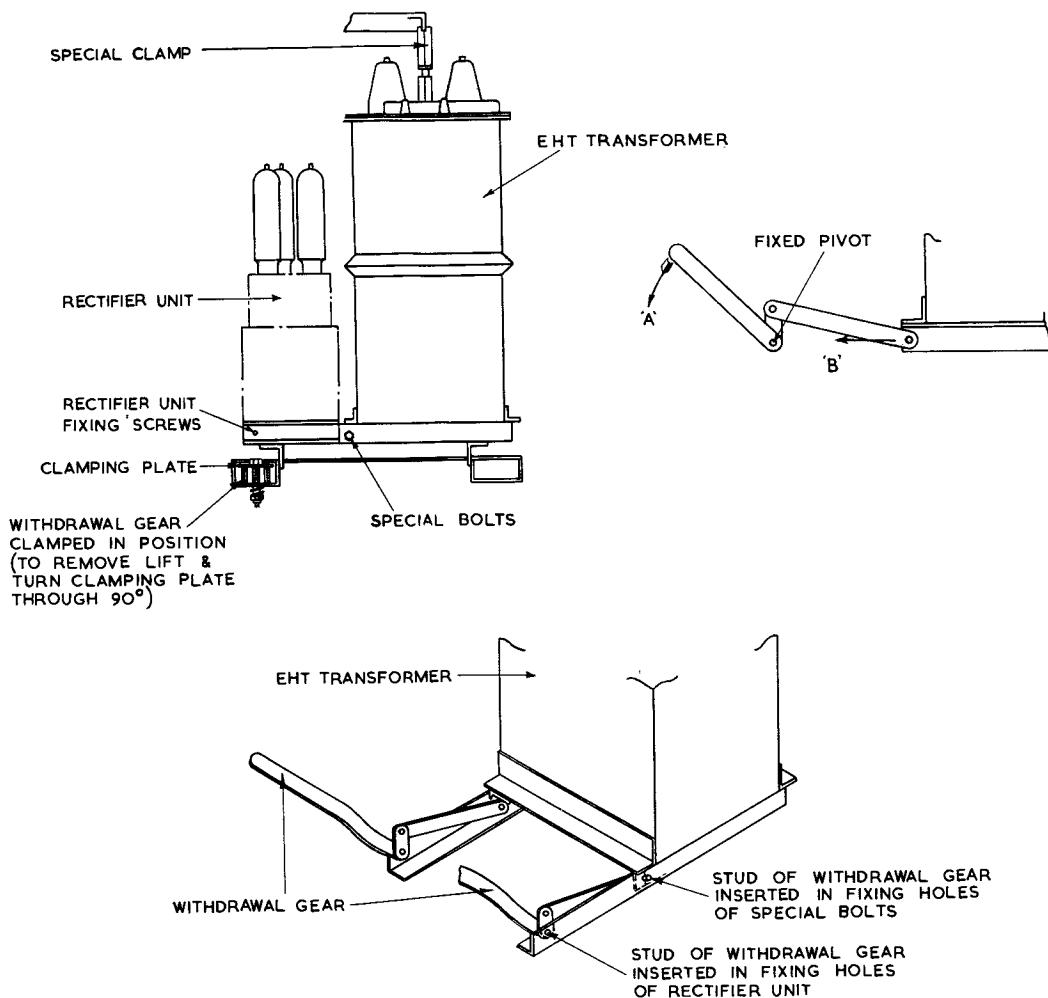


Fig. 2. Withdrawal of EHT transformer

- (5) Apply a steady force in the direction of *arrow A*; this will be sufficient to move the transformer outward in direction of *arrow B* to clear dowel pins on framework.
- (6) Remove withdrawal gear and pull transformer clear by hand.
- (7) To replace, reverse above sequence.

HT capacitor

12. The HT capacitor, mounted in the centre compartment behind the discharger unit, is held in place by two metal straps, tightened by screws, and also by special clamps between the top of the capacitor and the frame of the transmitter. If the HT capacitor is removed, it should be shorted across with an earthing stick before and after it is disconnected and then the terminals permanently shorted with a length of wire which must be left on until the capacitor is reconnected in circuit. This is to prevent the build-up of a residual charge.

Auxiliary power units — (fig. 3-8)

13. These units rest on Z-shaped brackets fixed to telescopic runners and are held in place by clamping plates which fit over the top of these Z-brackets. To remove a unit the two fasteners holding it in

should be undone and the unit pulled forward. The nuts holding each of the four clamping plates should be undone and the plates removed. The various connectors should be disconnected and the unit lifted off the runners. When replacing, this process should be reversed. The clamping plates should be adjusted so that there is no slackness in assembly before the nuts are tightened.

Withdrawable units

14. The trigger unit, monitoring unit and control unit (*fig. 9*) may be removed as follows:—

- (1) Turn the GATE and POWER switches to OFF to release the units.
- (2) Release the four Oddie fasteners on the front panel of the unit by turning them through 90 deg. with a screwdriver or coin and then withdraw the unit fully.
- (3) At the rear of the chassis on each side are two eccentric locking clamps. Release these by pushing the tops of the clamps smartly outwards.
- (4) Disconnect the various connectors and lift the unit off the runners.
- (5) To replace the units, reverse the procedure detailed in operations (1) to (4).

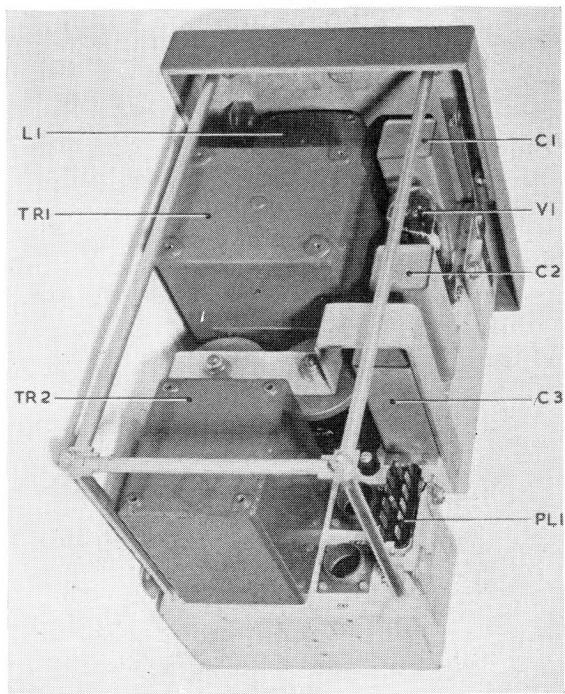


Fig. 3. Power unit Type 876—component layout above chassis

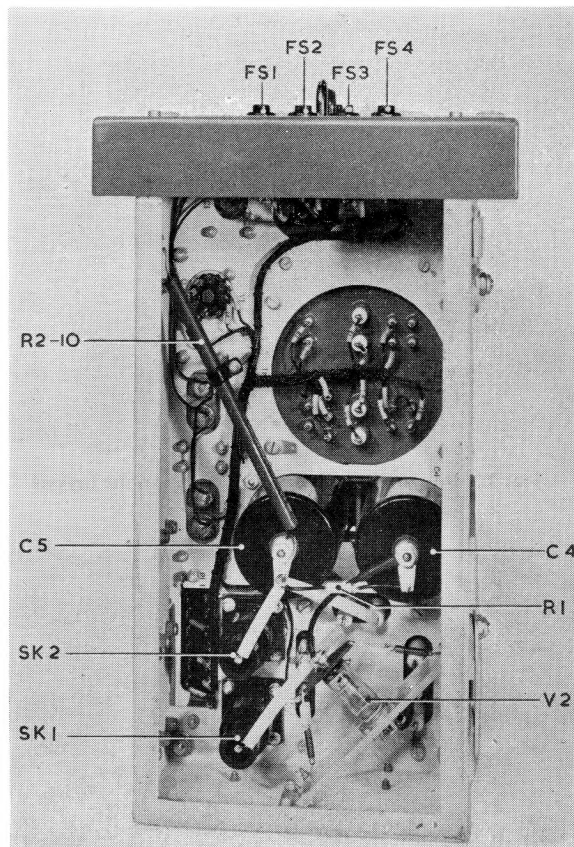


Fig. 4. Power unit Type 876—component layout under chassis

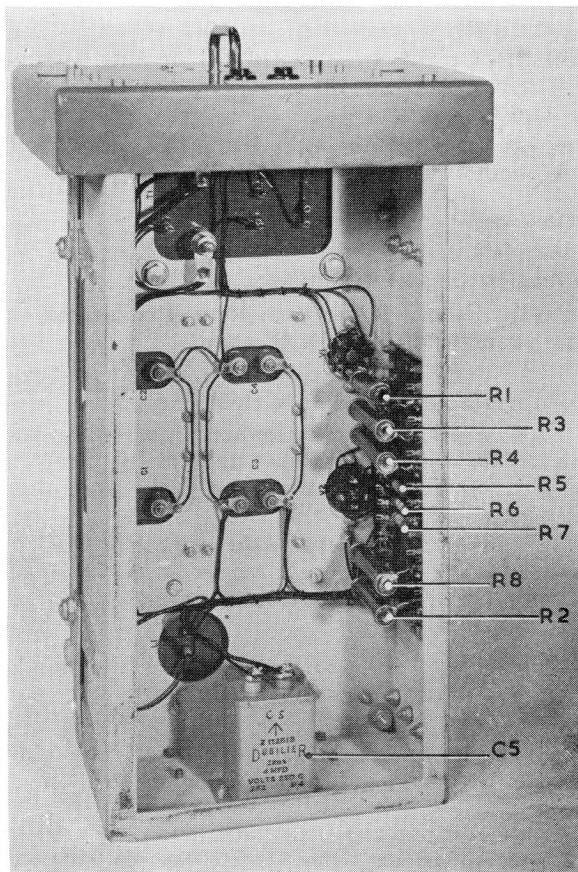


Fig. 6. Power unit Type 877—component layout under chassis

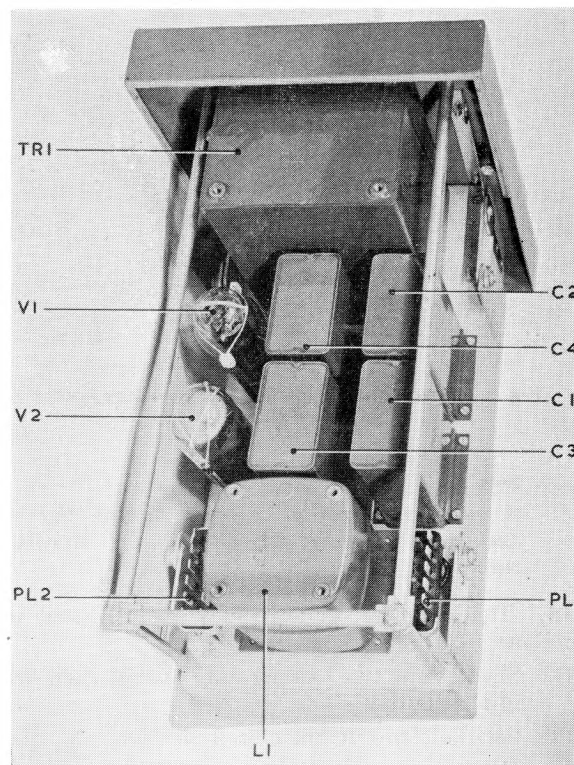


Fig. 5. Power unit Type 877—component layout above chassis

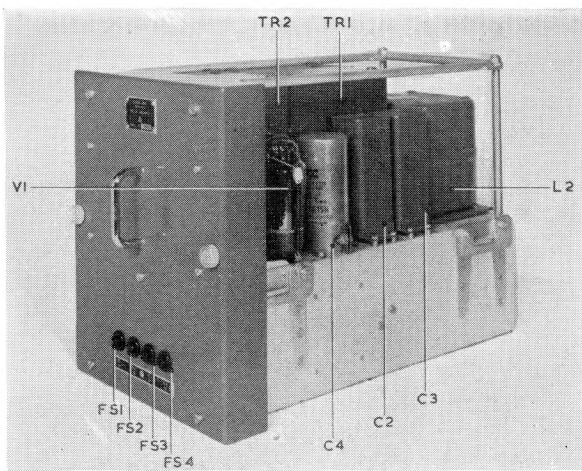


Fig. 7. Power unit Type 878—component layout above chassis

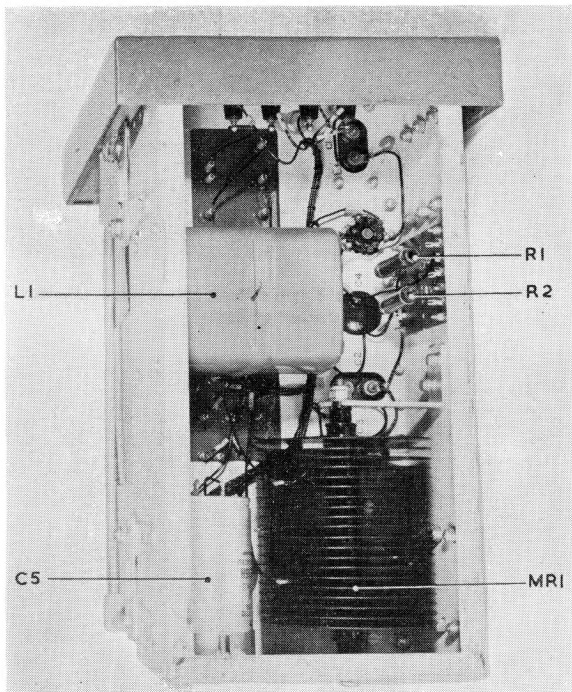


Fig. 8. Power unit Type 878—component layout under chassis

Note . . .

A quick snap action is more effective than a sustained pressure for closing the eccentric clamps.

15. The eccentric clamps may be adjusted as follows:—

- (1) Slacken the two locking nuts (one at each side of the clamp).
- (2) Set the clamp in the closed position.
- (3) Rotate the cam pivot screws (that is, those carrying the locknuts) until all slackness is taken out of the mechanism.

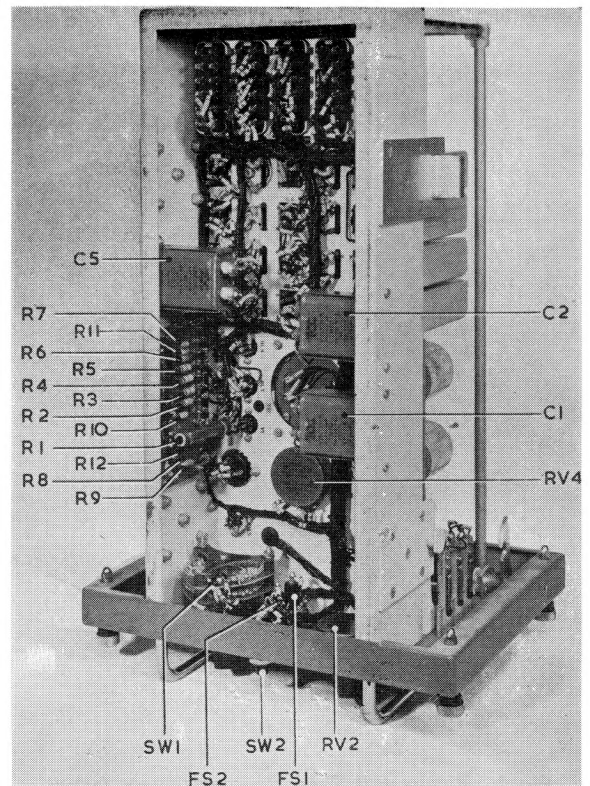


Fig. 9. Control unit Type 616—component layout under chassis

- (4) Lock pivots by means of locking nuts, holding pivot screws at the correct setting while this is done.
- (5) It is important that loading is distributed equally over both pivots.

Cableforms

16. The coding used on the cableforms in the transmitter is as follows:—

- (1) Each unit has been given a code number, for example, 20 is the trigger unit.
- (2) Each cable has numbered sleeves fitted which, reading from left to right, indicate:—
 - (a) The unit code number (first two figures)
 - (b) The plug on that unit (middle figure)
 - (c) The pin on that plug (last two figures).

Note . . .

A typical example is the lead 20111 to 05106 which goes from the trigger unit, plug PL1, pin 11 to the power unit (mon.), plug PL1, pin 6.

There are two exceptions. Where the middle figure is zero it indicates either

- (d) that the lead is terminated in a coaxial plug in which instance, the corresponding socket number is indicated by the last two figures, or
- (e) that the lead goes direct to a valve anode, in which instance the last two figures indicate the valve number.

For example, 20014 means trigger unit, SK14. and 38001 means HT rectifier, V1.

TABLE I

Unit code numbers

Unit title	Code No.
Transmitter rear pillar	01
Capacitor unit (on transformer unit Type 174)...	02
Switch unit Type 407	03
Meter unit (LH door)	04
Power unit (mon.) Type 876	05
HT contactor	07
Transformer unit Type 174	08
Resistor panel	09
LT contactor	10
OFF button	11
ON button	12
FILS ON lamp	13
Power unit Type 878	14
HT transformer	15
Discharger unit	16
Power unit (heaters) Type 887	17
LT Variac	18
Power unit (trigger) Type 877	19
Trigger unit Type 2... ..	20
Monitoring unit Type 82	21
Power switch	22
HT UP lamp	23
Fuse (DC ON lamp)	24
HT ON lamp	25
HT Variac	26
Fuse panel (HT Variac)	27
DC ON lamp	28
Rect. unit Type 26	29
Fuse panel (fans)	30
KV meter	31
Fan (HT compartment)	32
Fan (top left)	33
Fan (top right)	34
HT capacitor	35
HV socket on rear pillar	36
Pulse forming network	37
HT rectifiers... ..	38
Stand-off insulator	39
Stand-off insulator	40
Stand-off insulator	41
Pulse transformer	42
Control unit Type 616	43
Capacitor Type 191 (behind control unit Type 616)	46
Capacitor Type 191 (by pulse transformer)	47
Capacitor for 32	48
Capacitor for 33	49
Capacitor for 34	50

Monitoring unit Type 82 — (fig. 10 and 11)

Changing CRT

17. To remove the CRT, the procedure is as follows:—

- (1) Slacken coin-slotted screw securing bracket at base end of CRT.
- (2) Slide tube and bracket back and lift up so that bracket is released from chassis.
- (3) Remove base connector, slide tube out of housing and remove mu-metal screen.

18. To insert CRT the procedure outlined in para. 17, should be reversed.

Changing V16 and V17

19. V16 and V17 are mounted underneath the chassis, and V16 is at -3kV so care should be taken that the EHT supply is off and the EHT capacitors discharged before this valve is changed.

Changing C36

20. C36 is mounted at the rear underside of the chassis under a bridge formed by three tagboards. By removing four screws securing the tagboard mounting brackets to the chassis, the whole tagboard assembly can be lifted clear, without unsoldering any wires, to give access to the capacitor.

Trigger unit Type 2 — (fig. 12 and 13)

Amplifying unit Type 301 (fig. 14)

21. Only the video amplifier valve (V5) may be changed in this unit without realigning the unit afterwards. If any other valves should become faulty the unit should be changed for a spare one.

Power unit (monitor) Type 876

22. The EHT rectifier V2 is located underneath the chassis, mounted on an insulating bracket. As a precaution it is advisable to earth the EHT supply before changing valves.

23. The bleeder chain R2–R10 is housed in a protective tube (fig. 4) and should be changed as a complete assembly.

Changing main thyatron

24. If it becomes necessary to change the thyatron proceed as follows:—

- (1) Open GATE and POWER switches so that EHT is earthed.
- (2) Remove front panel covering discharger compartment and check with earthing stick that EHT is discharged.
- (3) Remove top cap of thyatron and disconnect the three leads from the underside of the thyatron, noting carefully where they are connected.
- (4) Undo the clamp around the base of the thyatron and remove it.

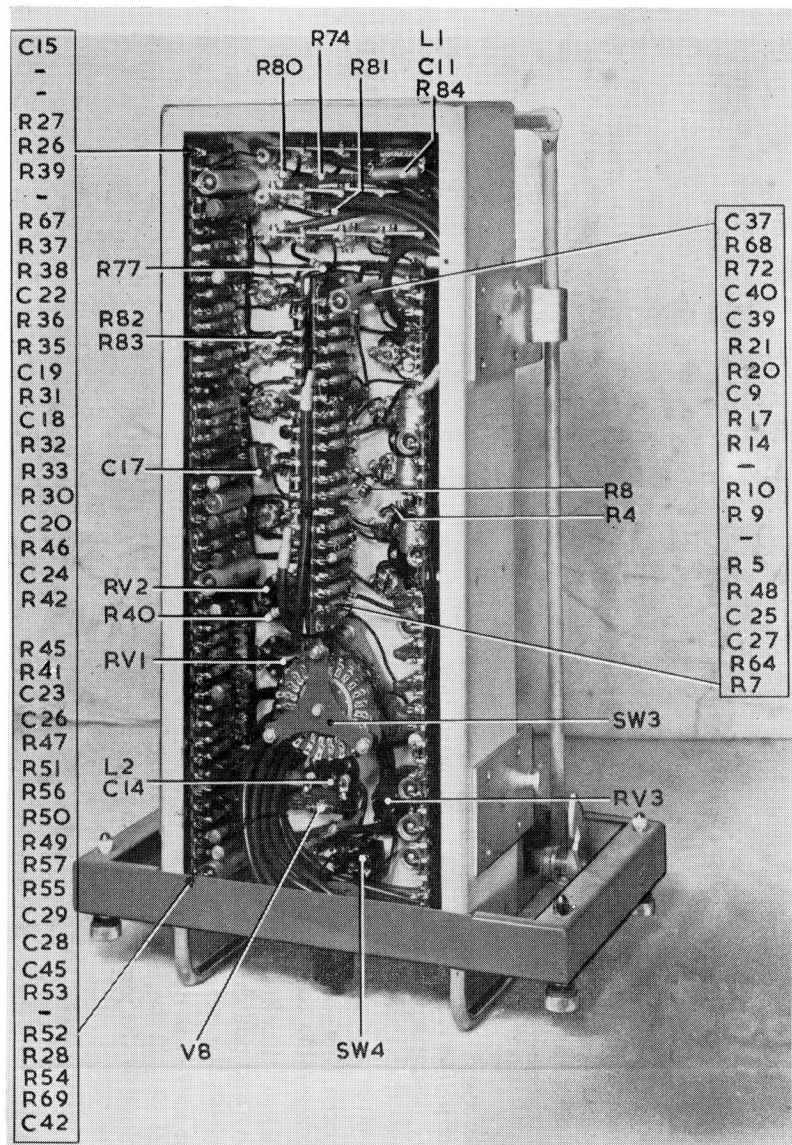


Fig. 12. Trigger unit Type 2—component layout (1)

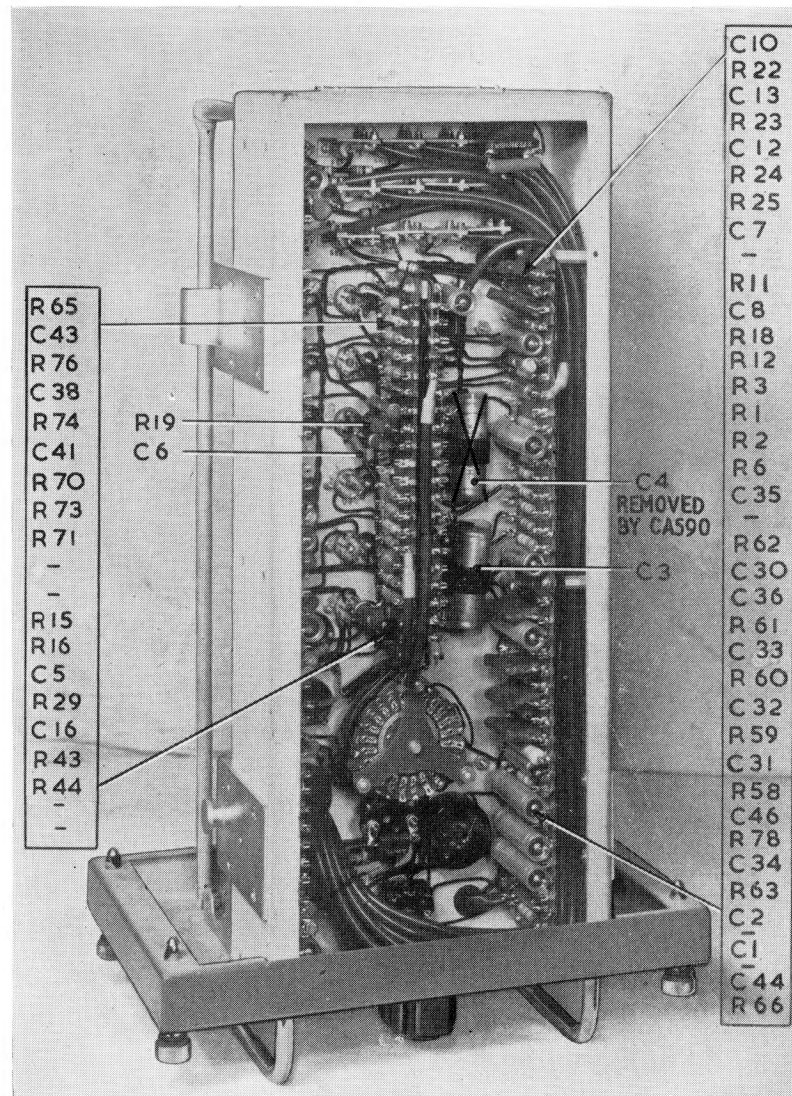


Fig. 13. Trigger unit Type 2—component layout (2)

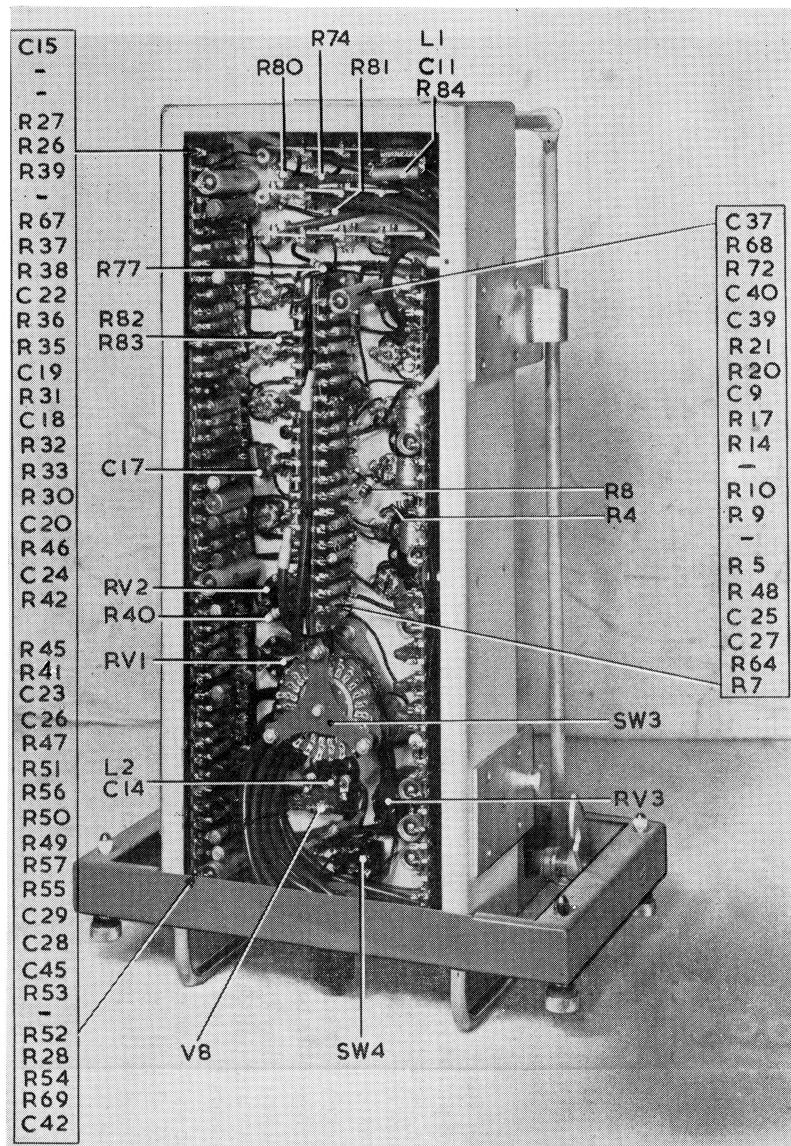


Fig. 12. Trigger unit Type 2—component layout (1)

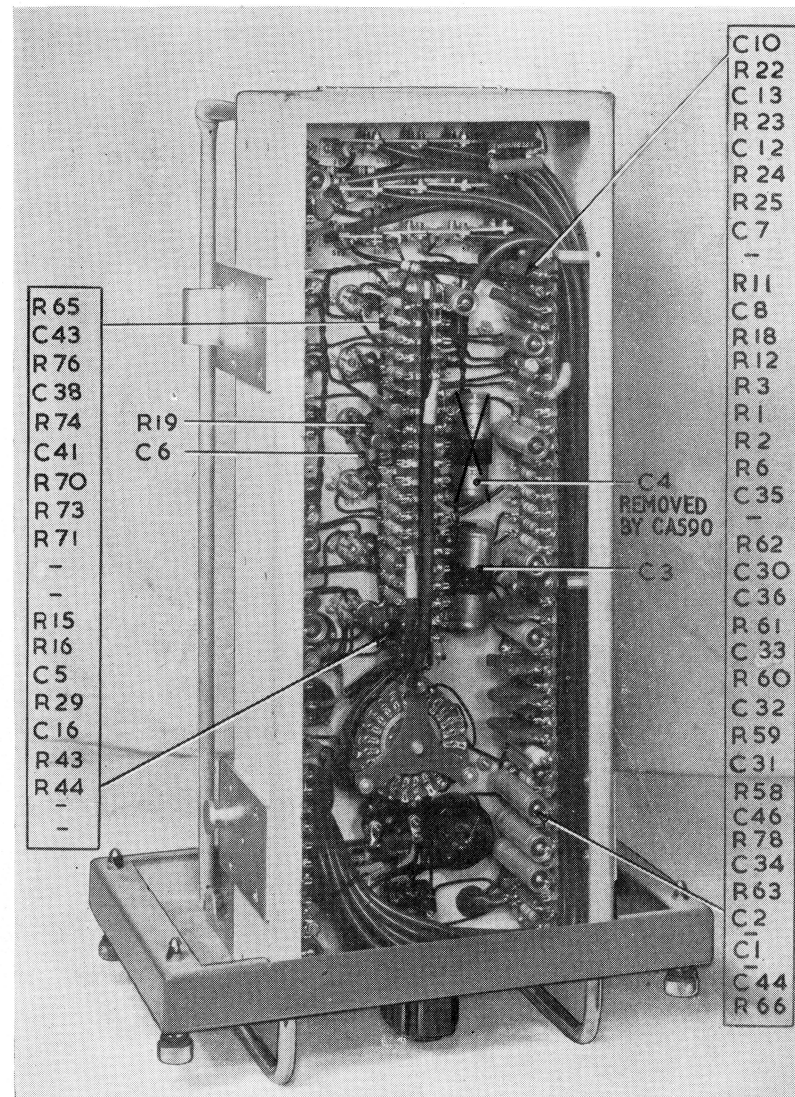


Fig. 13. Trigger unit Type 2—component layout (2)

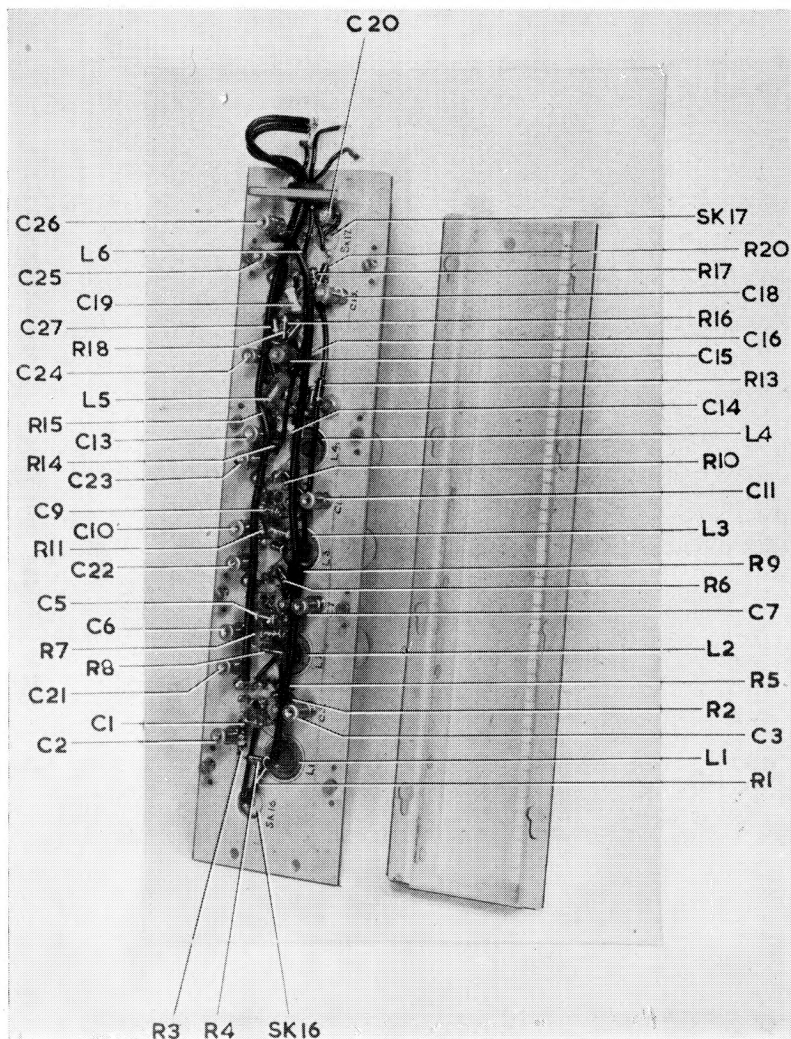


Fig. 14. Amplifying unit Type 301—component layout

Spark gap unit

25. The new thyratron may now be inserted and its base clamped, the base leads connected in the same positions as those previously removed and the top cap replaced.

26. The spark gap unit, through which the RF oscillator pulsed HT supply is fed, is mounted on an auxiliary mounting on top of the pulse transformer. To change the valve Type CV2902 the procedure is as follows:—

- (1) Slacken the knurled knob on the top of the sub-assembly to free the anode top cap.
- (2) Slacken the knurled knob underneath the valve and pull the top cap support forward till it clears the top cap, then swing it to the left.
- (3) The valve can now be pulled straight forward. Care should be taken not to damage it by rocking as the pins are mounted in an all-glass base.
- (4) To insert reverse this procedure.

The mount which supports the spark gap (CV2902) incorporates an auxiliary spark gap which fires if

the main gap fails. The CV2902 can be checked for satisfactory operation by viewing it through the hole in the rear panel of the transmitter. Whenever it is changed the auxiliary spark gap should be checked for burning, and cleaned if necessary. Its gap is set at 40 thou. by a mica spacing washer or washers.

Changing RF oscillator valves

27. The RF oscillator valves are changed as follows:—

- (1) Slacken nut at centre of horizontal bar connecting ends of inner filament leads and swing bar to one side.
- (2) Remove two bolts securing bridge, at end of cathode lechers, to bracket.
- (3) Grasp cathode lechers with both hands just above valve and lift upwards firmly without rocking.
- (4) Unscrew valve by turning counter-clockwise and lift out.
- (5) Remove plugs screwed to bottom of anodes and attach to replacement valves.
- (6) Screw in the substitute valves.
- (7) Replace cathode lechers.
- (8) Replace and tighten bolts.
- (9) Reconnect filament straps.
- (10) Close covers.
- (11) Tune the transmitter in accordance with Part 1, Section 7, Chapter 2.

Note . . .

Valves are not supplied in matched pairs but should be kept in pairs once they have been run. Valves are supplied "aged", but it may be necessary to run new valves at a reduced HT for a few hours to avoid the possibility of an internal flashover.

Test meter unit

28. To obtain access to the crystal or any other of the components a large rectangular panel (held in place by nine 4BA screws) on the rear of the left-hand door must be removed.

Switch unit Type 407

29. To reach the interior of this unit for servicing, etc., it must first be removed. This is done as follows:—

- (1) Remove discharger unit and control unit Type 616.
- (2) Earth the HT line with the earthing prod supplied.
- (3) Short the HT capacitor at its terminals by means of a length of wire.

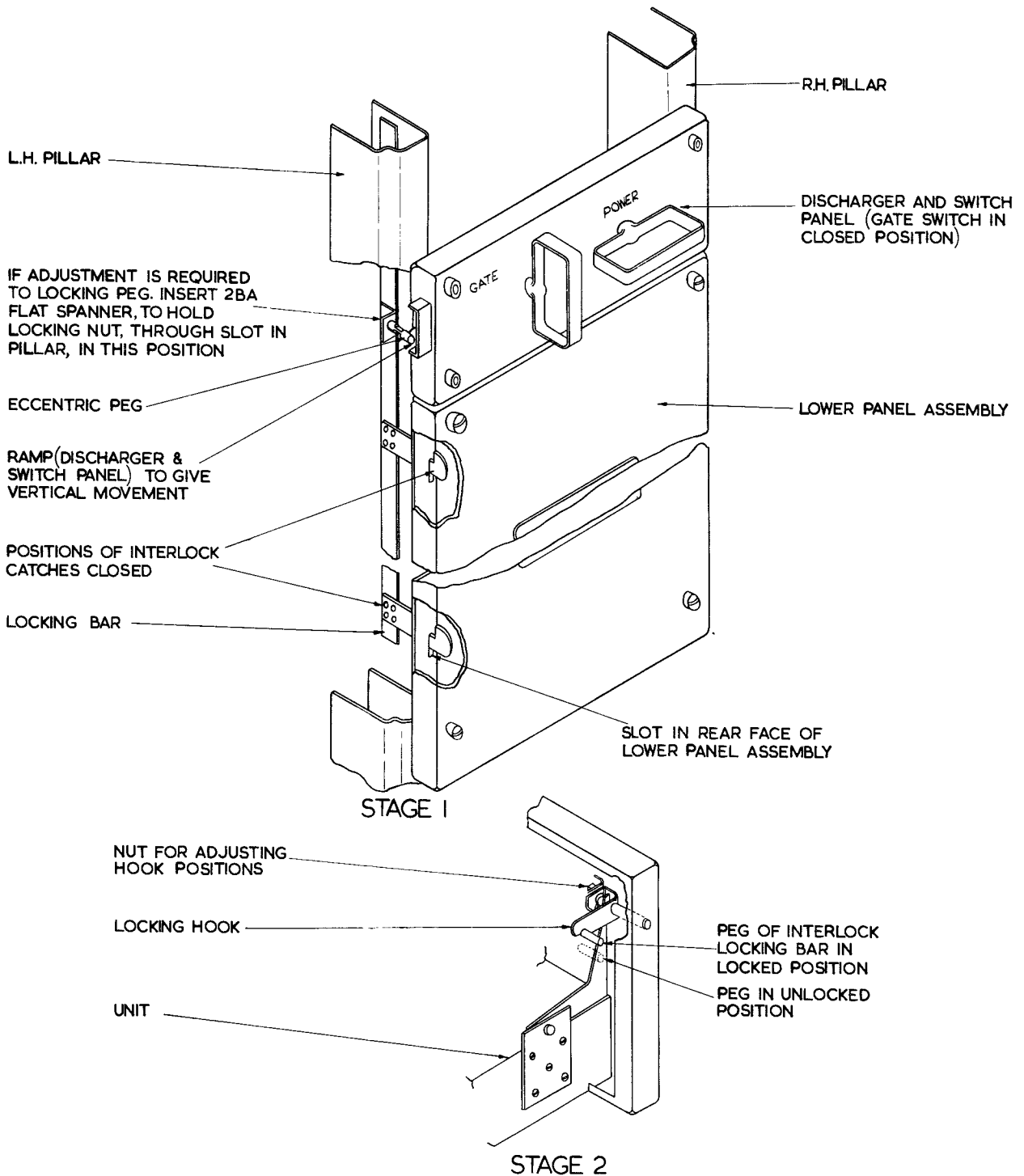


Fig. 15. Adjustment of interlock mechanism

- (4) Remove the connection to the POWER switch and to the EHT circuits at the rear of the unit.
- (5) Unscrew the four captive bolts holding the front panel of the unit to the frame. The unit can then be pulled forward.

Adjustment of interlock mechanism (fig. 15)

30. (1) Check that operation of the GATE switch handle on the switch unit results in a vertical

movement of approximately .31 in. of the locking pegs projecting from the LH pillar.

- (2) Check that operation of the GATE switch locks the lower panel in position when it is operated. If necessary the position of the locking bar can be adjusted (fig. 15).
- (3) Turn the GATE switch to LOCKED but with units withdrawn, thereby lifting pegs.

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- (4) Adjust the locking hooks on chassis so that by pushing units home the hook rides over and locks on to the locking peg. The unit should now be locked.
- (5) Open the GATE switch, thus lowering the locking pegs, when it should be possible to withdraw units. If necessary, adjust the locking hooks to ensure this.

Setting up Type 7 transmitter

31. The transmitter Type T.3705 is set up as follows:—

- (1) Check that the contacts on the LT and HT contactors are clean and make good contact, mechanically, when operated by hand.
- (2) Check that the high-voltage insulators in the rectifier bay are not damaged in any way.
- (3) Check that the various units of the transmitter are installed in their correct positions and that all valves are in place.
- (4) With the GATE switch on the switch unit Type 407 open, check that the POWER switch cannot be closed.
- (5) With the GATE switch closed, check that the POWER switch can now be closed.
- (6) With the POWER switch closed, check that the GATE switch cannot be opened.
- (7) With GATE and POWER switches open, close the two doors, fit the cover in front of the discharger unit (if not already fitted) and close all sliding units.
- (8) Operate the GATE switch and check that it is impossible to open the doors, remove the cover or to withdraw units.
- (9) Open the GATE switch, withdraw the sliding units, close the GATE switch again and then check that the sliding units can be pushed home, and remain locked in the closed position when this is done.
- (10) Open the GATE and POWER switches, remove the discharger unit compartment cover and disconnect the top cap connector to V1 (Type CV372). Withdraw the control unit Type 616 and remove RLT (one of the thermal delay switches). Connect the modulator dummy load to the EHT socket in the bottom of the RF compartment, running the cable from the load in through the base of the transmitter. Connect, with long test leads, a test meter Type D, set to the 75V AC range, across the heater connectors for the oscillator valves on the power unit Type 887.
- (11) Close the RH (oscillator) door.
- (12) Close the GATE and POWER switches. The DC ON lamp should light. Check that the meter reading on the LH door is 290 ± 15 per cent when the switch is set to 50V DC.
- (13) Press the ON button, check that the FILS ON lamp lights and wait *two minutes* for the valves to warm up. Check the heater voltage

which should be 16 volts ± 2 per cent. If this is not so, remove the panel at the rear of the transmitter (rectifier compartment side) and adjust the knob of the LT Variac which is thus exposed, until the meter reading is correct. Replace the panel.

- (14) Check that the three fans are working and that those on the top of the cabinet are extracting air from the cabinet.
- (15) Check the meter readings on the left-hand door, as follows:—

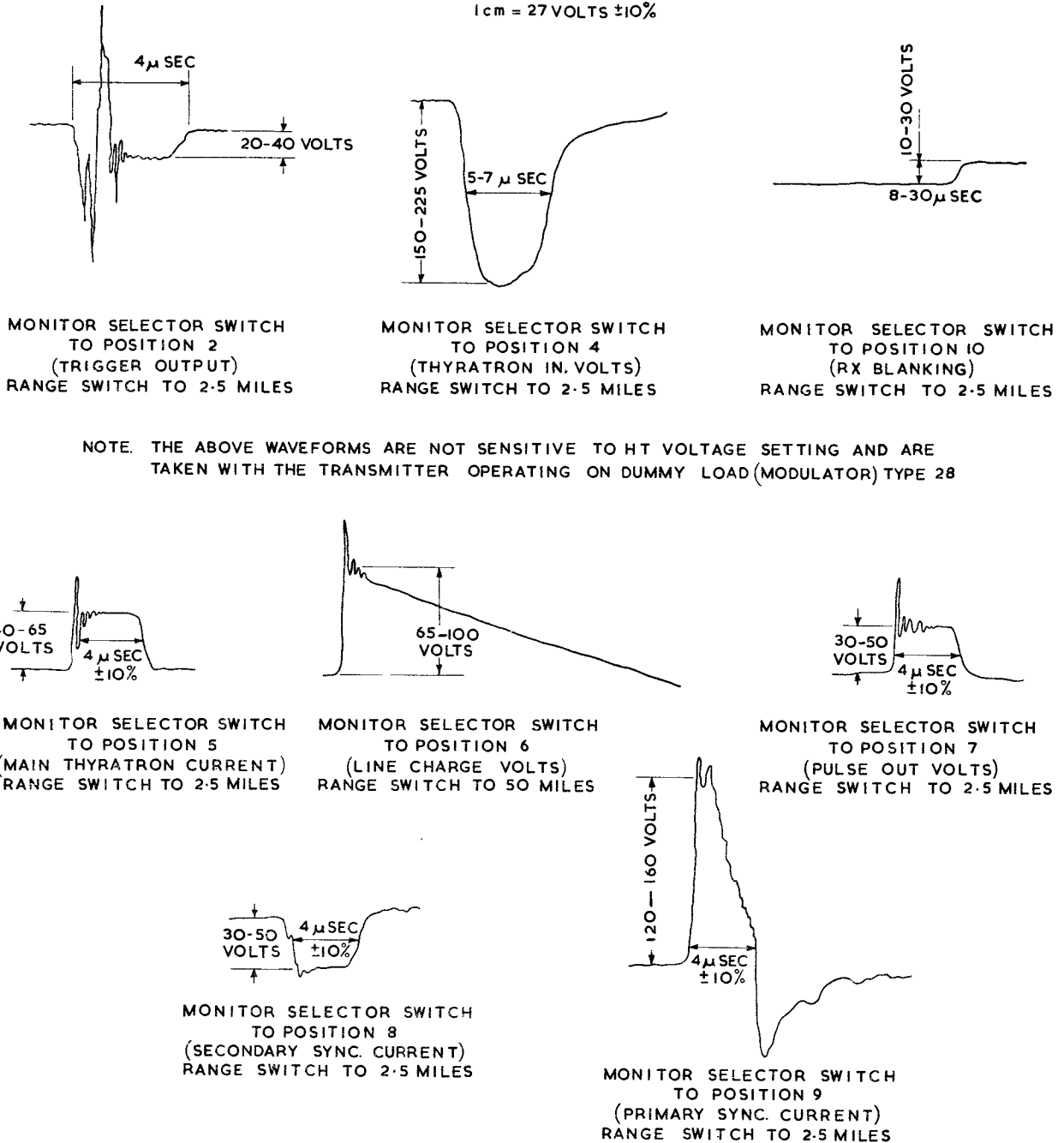
SUPPLY VOLTAGE	...	140 $\pm$ 15 per cent.
HEATER VOLTAGE	...	160 $\pm$ 15 per cent.
TRIGGER BIAS	...	450 $\pm$ 10 per cent.
50V DC	...	290 $\pm$ 15 per cent.
GENERAL POWER		
UNIT...	...	360 $\pm$ 15 per cent.
MONITOR POWER		
UNIT...	...	400 $\pm$ 15 per cent.
DISCHARGER UNIT	...	240 $\pm$ 15 per cent.
TRIGGER POWER		
UNIT...	...	240 $\pm$ 15 per cent.

Note . . .

All other positions should be reading zero. The reading of heater voltage should be noted to within ± 1 per cent.

- (16) Press the remote OFF button and check that all the transmitter fans and filaments are switched off. Operation of this remote OFF button should now have no effect on the transmitter. Reconnect the top cap of V1 (Type CV372) on the discharger unit.
- (17) Press the remote ON button and check that the transmitter fans and filaments are switched on. Operation of this remote ON button should now have no effect on the transmitter.
- (18) Switch on monitoring unit Type 82 and after waiting *one minute* adjust the BRILLIANCE and FOCUS controls to give a suitable scan. Check the operation of the shift controls and rotate the range selector switch to check that there is a scan on all ranges.
- (19) Put the CAL switch to ON, set the RANGE AND CALIBRATION SWITCH to the 2.5 MILE range and measure the duration of the sweep (using the 2 μ s cal. markers that are displayed on the sweep) which should be 30μ s $\pm 4 \mu$ s. (13 to 17 cal. marks). The trace should be at least $2\frac{3}{4}$ in. long. Repeat for the 50-mile range using the 5-mile cal. markers; the duration of the trace should be 50 miles ± 5 miles (9 to 11 cal. marks) and its length not less than 3 in. Repeat for the 100-mile range, for which the trace duration should be 100 ± 10 miles (18 to 22 cal. marks) and the trace length more than 3 in. Finally, repeat for the 200-mile range, for which the trace duration should be 18–24 markers on the first half of scan and the trace length more than 3 in.

DEFLECTION SENSITIVITY OF MONITORING UNIT

1 cm = 27 VOLTS $\pm 10\%$ 

NOTE... THE ABOVE WAVEFORMS ARE TAKEN WITH AN HT VOLTAGE SETTING OF 5KV AND
A MEAN HT CURRENT OF 200mA AND WITH THE TRANSMITTER OPERATING ON
DUMMY LOAD (MODULATOR) TYPE 28

Fig. 16. Waveforms on transmitter

(20) If the results detailed in operation (19) cannot be obtained, the SWEEP DURATION control (RV102) and the SWEEP LENGTH control (RV38) should be adjusted to produce, on all ranges of SW1, linear traces of the durations and lengths specified.

(21) With the RANGE AND CALIBRATION SWITCH at

2.5 MILES and with cal. markers on, rotate the MONITOR SELECTOR switch on the trigger unit Type 2. Check that the waveforms in the following positions comply with those in *fig. 16*. It may be necessary to connect a 220-ohm resistor between SK9 at the rear of the transmitter and earth if this socket is not already terminated.

(A.L.11, Dec. 56)

- (a) Trigger output.
 - (b) Main thyatron input volts.
 - (c) Rx blanking (the duration of this is controlled by means of the preset control RV1 mounted on the trigger unit Type 2. This should be set to give maximum pulse width).
- (22) Press the transmitter OFF button, replace RLT in the control unit Type 616 and check the following operating delay times for indicator lights on the control units from the time of switching on.
- FIRST DELAY ... on switching on
THIRD DELAY ... 100 sec. ± 25 per cent.
VARIAC DOWN ... Less than 60 sec.
FIFTH DELAY ... 200 sec. ± 25 per cent.
RUNNING UP ... 250 sec. ± 25 per cent.
- (23) To check the normal operational functions of the control unit, run the HT up to a nominal level so that the HT UP lamp lights. Depress RLA manually. The HT UP lamp and the HT ON lamp should be extinguished. The HT RESET lamp should be extinguished. The HT RESET lamp should light. The HT ON and RUNNING UP lamps should light after a period of not more than 60 sec. Depress RLA a second time before the HT UP lamp lights. The transmitter should trip so that it is necessary to depress the ON button to obtain supplies to the transmitter.
- (24) Repeat (23) for RLE.
- (25) Run the transmitter up to an HT of 7kV and check the front panel meter reading on HEATER VOLTS. If necessary, readjust the LT Variac to obtain the same reading as in (15).
- (26) Run the transmitter up to an HT of 5kV on modulator dummy load and check the following waveforms on the monitor 2.5 mile range, against those given in *fig. 16*:—
- (a) Main thyatron current.
 - (b) Line charge volts.
 - (c) Pulse out volts.
 - (d) Sec. sync current.
 - (e) Primary sync current.
- (27) Check that the transmitter does not fire on positions (a) MSW and (b) EXT of the TRIGGER switch except when (a) the capacity switch is running and (b) the master trigger unit is switched on.
- (28) Check that the transmitter does not fire on 250 c/s FREE RUN or on 500 c/s FREE RUN except when the "15/7" switch is at 15.
- (29) Press the OFF button open the doors and check that the HT circuits are not live with the earthing prod, replace the modulator dummy load by the RF oscillator and connect an RF dummy load, suitably stubbed off, to the feeder; then run the transmitter up and check that it operates satisfactorily, and is on the correct frequency, ± 0.2 Mc/s.
- (30) Switch the transmitter OFF, disconnect the RF dummy load and check the operation of the transmitter into the aerial system, and the beam selection switch on the monitoring unit. Check on a local echo that the GAIN control on the trigger unit is satisfactory when the monitor is displaying monitor output.

Adjustment of preset controls

32. There are four preset controls on the transmitter Type T.3705. These, which may be adjusted on site, are:—

RV2 (trigger unit Type 2)
RV102 (monitoring unit Type 82)
RV1 (control unit Type 616)
RV4 (control unit Type 616)

33. RV2 (trigger unit Type 2). This is set up as follows. With the transmitter running on MSW the procedure detailed in Part 1, Section 6, Chapter 2, para. 16, should be carried out except that RV2 is adjusted instead of the end plate of the capacity switch. The setting of the end plate of the capacity switch must not be disturbed.

34. RV102 (monitoring unit Type 82). This is set up when checking the monitor timebase, as mentioned in operation (20) of para. 31.

35. RV1 (control unit Type 616). This control should be adjusted as follows:—

- (1) When the transmitter is running, turn RV1 fully clockwise.
- (2) Press the HT RESET button and hold it in until a testmeter Type D, on the 300V AC range, connected between terminal 1 and brush on the HT Variac (transformer unit Type 174) reads 20V.
- (3) Release the button and, when the meter reads 40V, break RLF by hand (lifting the armature).
- (4) Holding RLF not operated, adjust RV1 until RLD just operates.
- (5) Release RLF, allow the meter reading to rise to about 80V and then press the HT RESET button.
- (6) Check that the VARIAC DOWN lamp lights when the meter reads 40V 5 per cent.

36. RV4 (control unit Type 616). This control should be adjusted as follows:—

With the HT SET control on the front panel set fully clockwise and the preset control RV4 set fully counter-clockwise, press the transmitter ON button and wait for the transmitter to run up. When the HT UP lamp lights note the reading on the built-in EHT meter. Turn RV4 slightly clockwise, press the HT RESET button. When the HT UP lamp lights again note the reading on the built-in EHT meter. Repeat this adjustment until (with the HT SET control still at 10) the HT UP lamp lights at when the reading on the built-in EHT meter is 7kV.

Note . . .

The transmitter EHT Voltage must not be allowed to rise above 7kV owing to the danger of flashing over and consequent damage to the capacity switch.

Chapter 3
RECEIVER

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Removal of units

1. If units are to be removed from the receiver cabinet it is necessary to take the power unit out before the RF and IF units which are withdrawn together as one assembly.

Power unit Type 886

2. The power unit may be removed as follows:—

- (1) Disconnect the two Mk. IV plugs, the coaxial plug and the Jones-type socket from the unit.
- (2) Undo the four captive screws (two at each end of the chassis).
- (3) Withdraw the unit by pulling it forward.

Amplifying unit (RF) Type 299 and amplifier (IF) Type A.3691

3. The RF unit (*fig. 3*) and the IF unit (*fig. 4*) may be removed as follows:—

- (1) Remove the power unit as detailed in *para. 2*.
- (2) Release the cable cleats which secure the two power cables from the RF and IF units to the power unit.
- (3) Disconnect the coaxial connectors.
- (4) Undo the six 2 B.A. nuts which hold the units in position.
- (5) Remove the units, complete with cables.

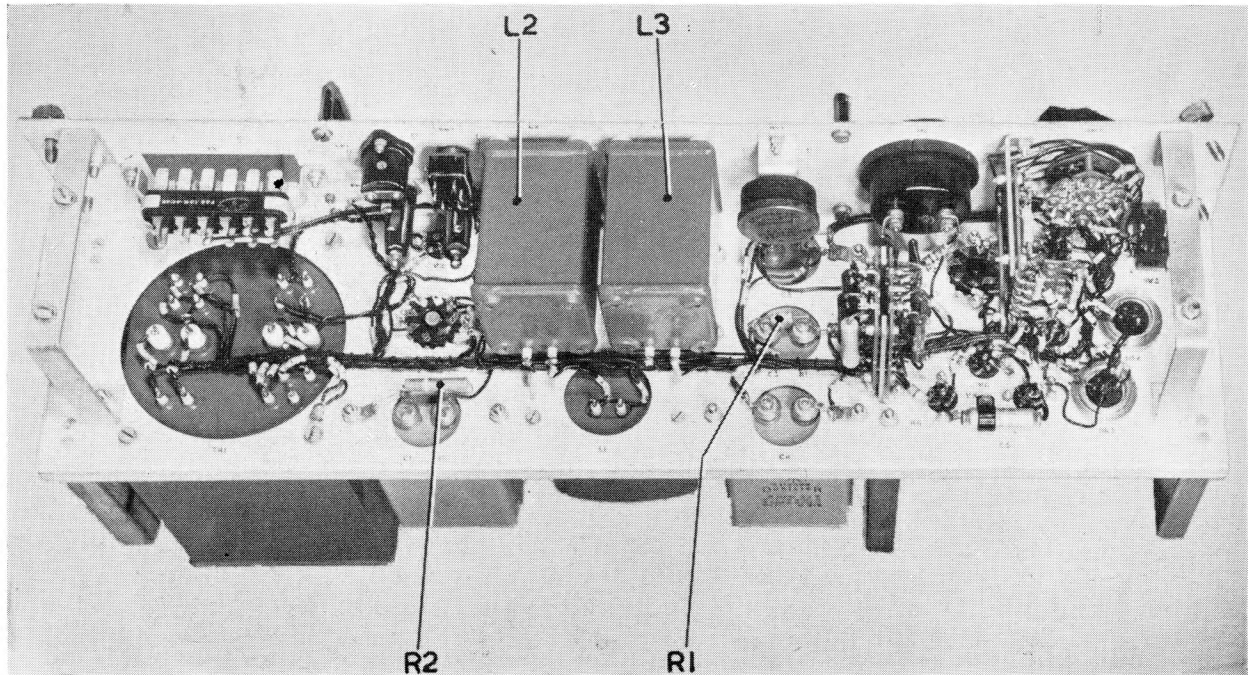


Fig. 1. Power unit Type 886—component layout under chassis

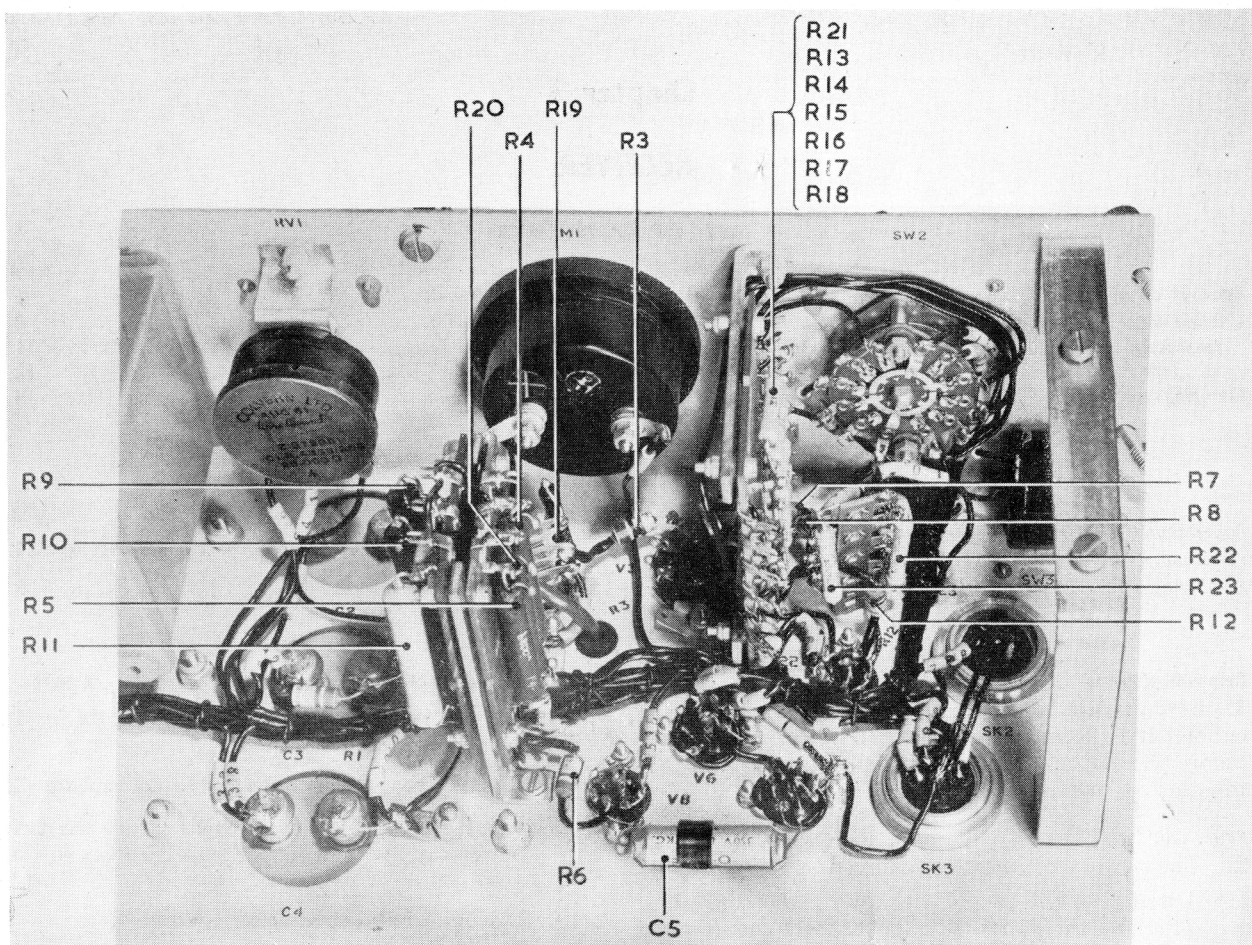


Fig. 2. Power unit Type 886—component layout of tagboards

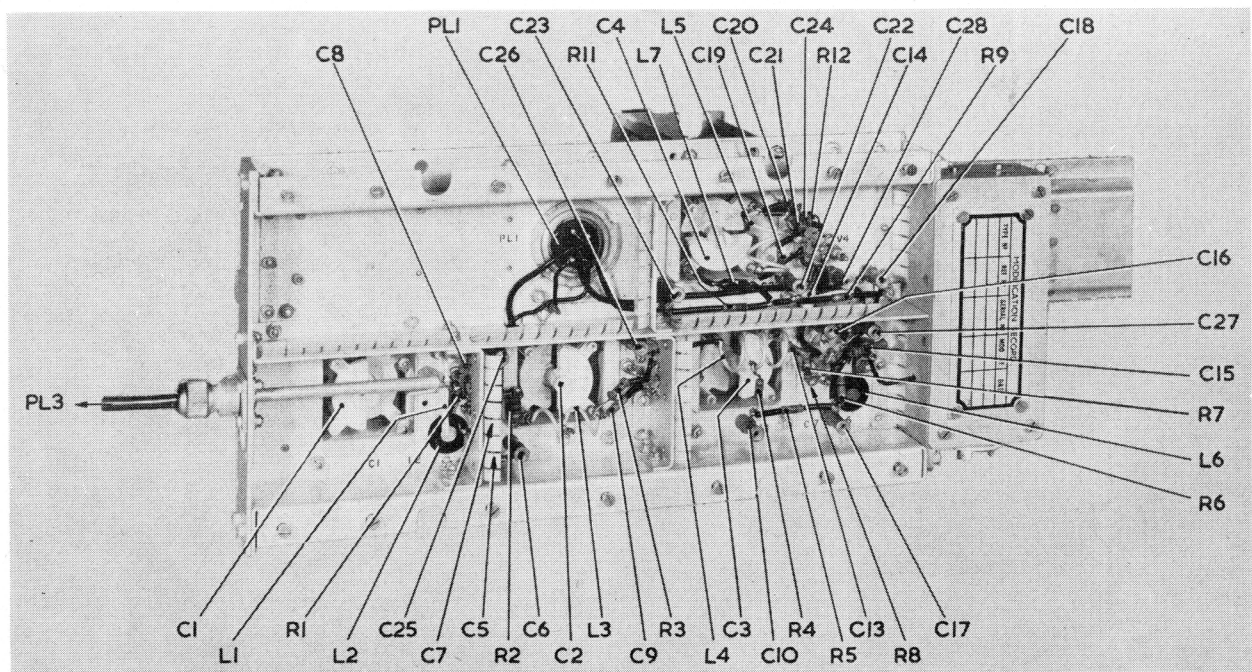


Fig. 3. Amplifying unit (RF) Type 299—component layout

Changing valves

4. Any of the valves in the power unit can be changed without difficulty. However, caution must be used when changing valves in the RF unit; the tuning of this unit must be checked at the first opportunity after the change is made. In no circumstances should valves be changed on the IF unit as this would entail realignment of the complete unit. If a valve fails in the IF unit, the complete unit must be changed (*para. 6 and 7*).

5. To change valves in the RF unit, remove the appropriate valve can and remove the valve using a B7G valve extractor if available. If an extractor is not available, then the valve should be removed by grasping it from underneath.

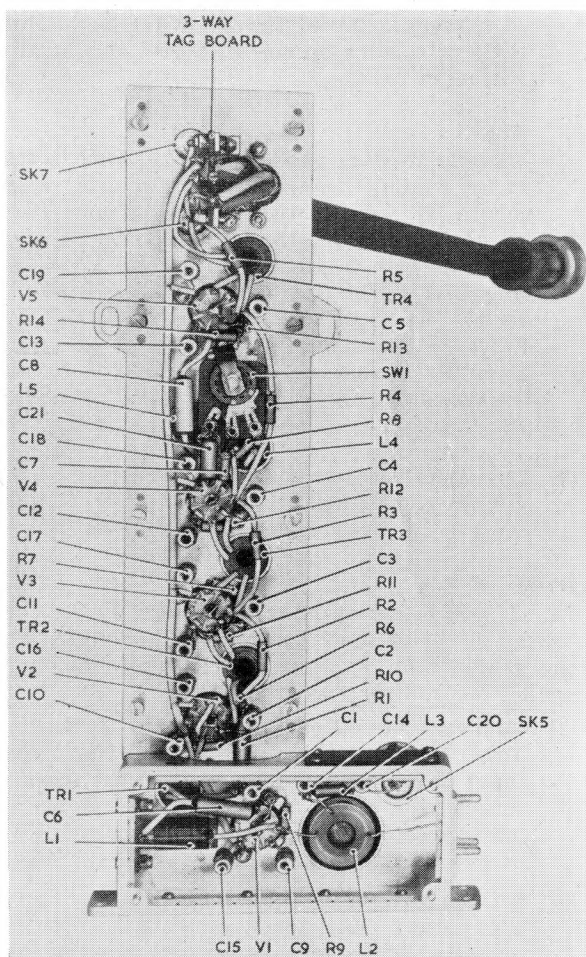


Fig. 4. Amplifier Type A.3691—component layout under chassis

Changing IF unit (*fig. 5*)

6. To change the IF unit, the RF and IF assembly must first be removed from the receiver cabinet as detailed in *para. 3*.

7. The procedure is then as follows:—

- (1) Turn the RF and IF assembly on its side.

Note . . .

It is not necessary to remove the RF unit cover when changing the IF unit; if the cover has been removed for some other reason, care must

be taken to ensure that the tuning controls are not damaged when the assembly is turned on its side.

- (2) Undo the screws securing the small baseplate to the IF unit and remove it.
- (3) Unsolder the lead from the RF unit at the IF input coil.
- (4) Remove the screws holding the RF and IF units together.
- (5) Remove the plate covering the hole in the end of the short arm of the faulty IF unit.
- (6) Remove the small baseplate and the 2 B.A. screw on the end of the replacement IF unit, and thread the wire from the RF unit through the hole thus vacated.
- (7) Bolt the RF unit and the replacement IF unit together.
- (8) Solder the wire from the RF unit to the appropriate tag on the IF input coil.

Note . . .

There is a wire, unsupported at one end, coming from the coil tag to which the input wire is connected. This wire should be so positioned that it is not likely to foul the chassis at any point. If necessary it can be looped back on itself and soldered to the coil tag at both ends; the wire must not be removed as it is required in other applications of the IF unit.

- (9) Take the small circular plate removed from the faulty IF unit, and bolt it on to the replacement.
- (10) Insert in the faulty unit the 2 B.A. screw removed in (6).
- (11) Replace the small baseplates on the two IF units and check that the replacement unit performs satisfactorily.

Valve currents

8. The current taken by any one valve can be checked by switching the meter on the power unit to read the total RF unit current *or* total IF current *or* total IF unit current, as appropriate, and noting the drop in meter reading when the valve in question is removed. Care must be taken to replace each valve in the socket from which it was removed.

9. The valve currents for the amplifying unit (RF) Type 299 should be as follows:—

V1	9 mA $\pm$ 10 per cent.
V2	7.5 mA $\pm$ 10 per cent.
V3	1 mA $\pm$ 10 per cent.
V4	10.5 mA $\pm$ 10 per cent.
Total feed	27.5 mA $\pm$ 20 per cent.

10. The valve currents for the amplifier (IF) Type A.3691 should be as follows:—

V1	9.5 mA $\pm$ 30 per cent.
V2	8.0 mA $\pm$ 30 per cent.
V3	11.0 mA $\pm$ 30 per cent.
V4	11.0 mA $\pm$ 30 per cent.
V5	11.0 mA $\pm$ 30 per cent.
Total feed	55 mA $\pm$ 20 per cent.

Noise factor

11. The best check on the performance of the amplifier Type A.3694 is to measure its noise factor. A more accurate method than that specified in Part 1, Sect. 6, Chap. 2 is to use a wideband amplifier such as the Amplifier (IF & VID.) Type A.3680, as follows:—

- (1) Connect one output of the amplifier to a 68-ohm load (terminating unit Type 34) and the other to the input of the amplifier A.3680, via an attenuator Type 113 set to give 12½ dB attenuation.
- (2) Connect a meter (multimeter Type 1 or multimeter CT38) between the junction of C29 and L16 on the A.3680 and earth. Set the meter to a suitable voltage range.
- (3) Set a signal generator Type CT53 to the station operating frequency, using a suitable wavemeter.
- (4) Inject the output of the signal generator into the RF amplifier, setting the four tuning dials to the correct readings as given by the calibration chart on the amplifier cover.
- (5) Tune the four controls on the RF unit to give maximum detector current.
- (6) Substitute the signal generator (noise) Type 1 for the signal generator Type CT53.
- (7) Connect a test set 4341 between the attenuator and the input to the A.3680.
- (8) With the noise generator switched on but with the RANGE switch at OFF, and with the test set 4341 switched to 0 dB adjust the gain control (on the front of the A.3680) until the meter has a suitable reading (for example 5V).
- (9) Switch the noise generator RANGE switch ON.
- (10) Switch the test set 4341 to 3 dB and adjust the noise generator output to give the same meter reading as obtained in operation (8). The reading of the meter on the noise generator gives the receiver noise factor. It should be not greater than 6, which corresponds to 8 dB.

Neutralizing

12. Unless the slug of coil L2 in the first stage of the amplifying unit is adjusted to provide the correct degree of neutralization, it is possible for a condition to arise during tuning in which the whole unit goes into oscillation. In extreme cases this may occur spontaneously during an operational period. The neutralizing adjustment should normally only need to be carried out after valve V1 (CV408) has been replaced, as the degree of neutralization required depends on the inter-electrode capacitances of the valve.

13. The procedure is as follows:—

- (1) Check the tuning of the amplifying unit.
- (2) Connect the output of a signal generator Type CT53 or TF801A, tuned to the radar Type 7 “spot” frequency, to the receiver input socket SK2 on the frame of the amplifier Type A.3694.

- (3) Connect the input of a test set Type 4341, with the SELECTOR switch set to DETECTOR, to the receiver output socket SK3 on the frame of the amplifier Type A.3694.
- (4) Insert a terminating unit Type 34 (68 ohms) into the monitor output socket SK4, also on the frame of the amplifier Type A.3694.
- (5) Set switch SW3 on the power unit Type 886 to OFF, thus open-circuiting the HT supply to the valve V1 in the amplifying unit.
- (6) Connect a multimeter Type 1 (Avometer model 8) set to the 1 volt DC range, across the output terminals of the test set Type 4341.
- (7) Adjust the signal generator output attenuator controls until a meter deflection of about two-thirds full scale is obtained.
- (8) Adjust the slug tuning of coil L2 to the point of maximum dip of the meter reading. This is the setting for the correct degree of neutralization.

Note . . .

In some existing units it may be found that a meter reading dip cannot be obtained, even though the slug is unscrewed to its limit. This is thought to be due to the fact that the average inter-electrode capacitance in valves CV408, as now fitted, differs from that of the valve supplied for the prototype unit, with the result that the range of inductance variation does not now cover the inductance value required for full neutralization. However, this matter is under investigation.

- (9) Disconnect all test equipment and restore all circuit connections to normal. Set switch SW3 on the power unit Type 886 to ON.

Checking IF gain

14. It will be necessary to check periodically the setting of the IF GAIN control RV2, mounted on the power unit Type 886. The procedure for setting this control is as follows:—

- (1) Connect the output of a signal generator Type CT53 to the input socket SK2, the input of the test set Type 4341 to the output socket SK3, and a terminating unit Type 34 (68 ohms) to the monitor output socket SK4, on the outside of the amplifier Type A.3694.
- (2) Set the selector switch on the test set Type 4341 to DET. and connect a multimeter Type 1 set to DC 2.5V. range, across the output of the test set.
- (3) Set the signal generator frequency to the radar Type 7 “spot” frequency CW and the attenuator controls to give 250 microvolts output. (If a signal generator Type TF801A is used the attenuator should be set to 52 dB).
- (4) Adjust, in turn, the four tuning controls (beginning with the local oscillator control C4) on the amplifying unit Type 299 for maximum reading on the meter, ensuring by suitable adjustment of the IF GAIN control that the reading never rises above 1.5V to avoid overloading the amplifier.

- (5) Repeat, two or three times, the operation described in sub-para. (4) above. In some cases it may also be necessary to unlock and adjust the cores of the HF coil L2 on the amplifier Type A.3691 and L6 on the amplifying unit Type 299. If so, these must be adjusted alternately several times for maximum reading on the meter, and locked after final adjustment.
- (6) After completing any such adjustment of L6 and L2, re-check the tuning controls on the amplifying unit Type 299.
- (7) Set the IF GAIN control (RV2) to give a reading on the meter of $1.4V \pm 0.05V$.
- 15.** If there is any doubt about the alignment of the amplifier Type A.3691, this should not normally be adjusted on site, but instead a substitution unit should be fitted.

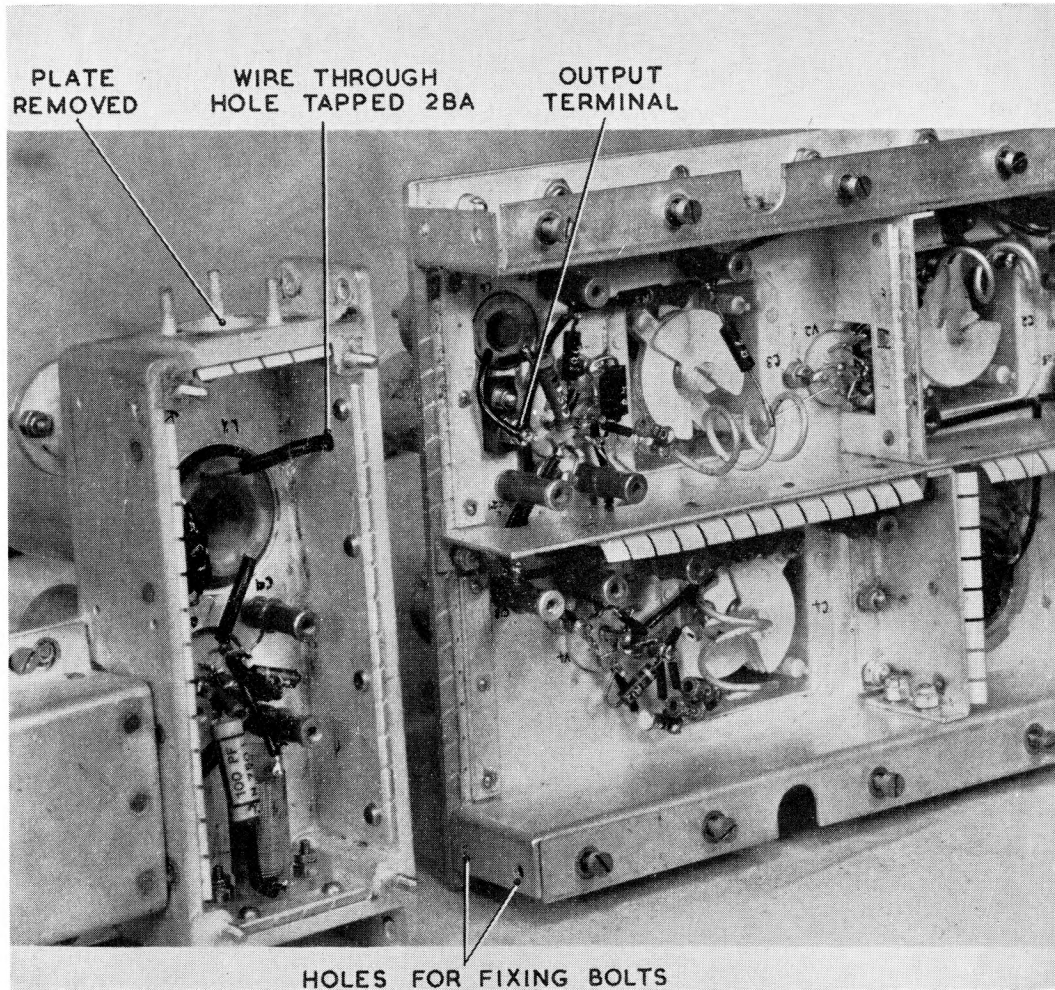


Fig. 5. Changing IF unit

Chapter 4

RADAR TYPE 79 Mk. I

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Introduction

1. These dismantling, alignment and testing instructions cover the main items of equipment used on radar Type 79, Mk. 1. Specific dismantling instructions are only included in those instances where difficulties might otherwise be experienced or where units might actually be damaged if the correct procedure were not used.

Test gear

2. The following test gear is required:—

<i>Equipment</i>	<i>Stores Ref.</i>
Test meter Type D1	10S/10610
Tester (insulation resistance) Type D	5G/203
Signal generator Type CT53	10S/16160
Signal generator Type 106	10SB/6086
Oscilloscope Type 13A	10S/831
Detector unit Type 73	10SB/6276
Wavemeter Type W.1649	10T/6045
Power unit Type 633	10KB/6205
Monitor (aerial power) Type 63	10T/6143
Output tester Type 57	10SB/6120
Test set Type 403	10S/16158
Variac transformer	—
2kV flash tester	—
18kV electrostatic voltmeter	—

Note . . .

Certain test equipment that must be made up locally is also required. Such items are described under the heading of the equipment with which they are used.

3. It should be ensured that, before commencing any test described in this chapter, the tappings on the mains transformer in each unit are set to the voltage of the supply mains used.

RECEIVER TYPE R.3684

Dismantling

4. To remove the RF sub-chassis:—

- (1) Undo the screws securing the right-hand side panel of the RF unit.
- (2) Unsolder the leads from the tag strip (these leads are not looped round the tags).
- (3) Loosen the grub screws in the fibre couplings attached to the tuning slugs.
- (4) Disconnect the RF input cable from the plug PL7 on the sub-chassis.
- (5) Remove the six screws by which the RF unit is attached to the main chassis.

5. Before removing the screening cans from the IF inductors it is necessary to unsolder the grid clip from the end of each grid lead. To remove unscrew two-6BA screws on top of can.

Gain control

6. For bench testing the receiver, an external gain control is used which must be made up locally. The control should consist of a 3,000-ohm reversed-log-law potentiometer connected to a suitable coaxial plug so as to give zero resistance when turned fully clockwise. As an alternative, a linear-law potentiometer may be used, but this will result in the control being cramped at one end of the scale.

Performance tests

RF coverage

7. The RF coverage of the receiver is determined, as follows:—

- (1) Connect the output of a signal generator Type CT53 to the RF INPUT plug of the receiver.
- (2) Connect the bench gain control to the GAIN CONTROL socket of the receiver. Set the control to maximum gain.
- (3) Connect the + OUTPUT socket of the receiver to terminal A1 of an oscilloscope Type 13A. Set the Y PLATE SELECTOR on the oscilloscope to A1A2.
- (4) Set the attenuator on the signal generator to approximately $62\mu\text{V}$. Inject a square-wave-modulated signal at a frequency of 200 Mc/s into the receiver.
- (5) Check that all RF circuits will tune through 200 Mc/s by indication of peak output on the oscilloscope.
- (6) Repeat the operations in (4) and (5) at a frequency of 210 Mc/s.

Signal-to-noise ratio

8. For this test the receiver is connected to the supply mains through a Variac transformer, set initially to give an output voltage equal to that of the input supply.

9. (1) Connect the output of a signal generator Type CT53 to the RF INPUT plug of the receiver.
- (2) Connect the bench gain control to the GAIN CONTROL socket of the receiver.
- (3) Connect the +OUTPUT socket of the receiver to terminal A1 of the oscilloscope. Set the Y PLATE SELECTOR switch on the oscilloscope to A1A2.
- (4) Set the signal generator to 200 Mc/s and adjust the receiver tuning controls for maximum output at this frequency.
- (5) Switch off the carrier from the signal generator. Adjust the receiver gain control in conjunction with the oscilloscope gain control to give 1 cm. of noise on the trace.
- (6) Switch on the signal generator carrier and inject a square-wave-modulated signal into the receiver.
- (7) Adjust the attenuator on the signal generator to give a deflection of 2 cm. The attenuator reading for this condition should not be greater than $32\mu\text{V}$.
- (8) Repeat the tests detailed in sub-para. (4) to (7) at a frequency of 210 Mc/s.
- (9) Repeat the tests detailed in sub-para. (4) to (8) with the Variac transformer set to give an output voltage approximately 6 per cent. less than the voltage of the mains supply. The readings obtained should not differ from those of the previous tests.
- (10) Repeat the tests detailed in sub-para. (4) to (8) with the Variac transformer set to give an output voltage approximately 6 per cent. higher than the voltage of the mains supply. The readings obtained should not differ from those of the previous tests.

Image ratio

10. (1) Connect the output of a signal generator Type CT53 to the RF INPUT plug of the receiver.
- (2) Connect a testmeter Type D set to the 15V DC range to test points X9 and X11 (positive to X11).

Note . . .

These tests points are at HT.

- (3) Connect the bench gain control to the GAIN CONTROL socket of the receiver. Set the gain control to maximum.
- (4) Inject a 200 Mc/s CW signal into the receiver. Tune the receiver for maximum output, indicated by maximum dip on the test meter. Adjust the attenuator on the signal generator until a reading of 2.6V is obtained on the meter. Note the setting of the attenuator.
- (5) Without altering the receiver gain control, re-tune the signal generator for peak output at the image frequency of approximately 178 Mc/s.
- (6) Re-adjust the attenuator until a reading of 2.6V is again obtained on the meter. The difference between the attenuator settings at the tune and image frequencies represents the image ratio of the receiver and should be not less than 10 dB.
- (7) Repeat the tests detailed in sub-para. (4) to (6) at a tune frequency of 210 Mc/s and an image frequency of approximately 188 Mc/s. The difference between the attenuator settings should not be less than 10 dB.

Overall bandwidth

11. The following procedure is to be adopted for checking the overall bandwidth through the IF stages:—

- (1) Connect a signal generator Type CT53 to the RF INPUT socket of the receiver.
- (2) Connect a testmeter Type D set to the 15V DC range to test points X9 and X11.
- (3) Connect the bench gain control to the receiver GAIN CONTROL socket.
- (4) Inject into the receiver a 158 μ V CW signal at a frequency of 200 Mc/s. Tune the receiver to this frequency. Adjust the gain control to obtain a deflection of 2.6V on the meter.
- (5) Increase the signal input to 316 μ V. Detune the signal generator to a frequency on one side of resonance until the meter again reads 2.6V. Note this frequency.
- (6) Detune the signal generator to a frequency on the other side of resonance at which a meter reading of 2.6V is obtained. The difference between this frequency and that obtained in (5) is the overall bandwidth of the IF amplifier, and should be within the limits 3.75 to 4.25 Mc/s.

Suppression

12. A 70V DC supply with the positive pole connected to the receiver chassis is required to test the suppression.

13. (1) Connect the signal generator, testmeter and gain control to the receiver as described in para. 11 (1) to (3). Set the gain control to maximum.
- (2) Inject a CW signal at a frequency of 209 Mc/s into the receiver. Tune the receiver to this frequency.
- (3) Adjust the attenuator on the signal generator to give a meter reading of 2.6V. Note the attenuator setting.
- (4) Apply the 70V negative supply to the PULSE INPUT socket on the receiver.
- (5) Increase the input signal by 60 dB. The meter reading should be not less than 2.6V in this condition.

Gain control range

14. (1) Connect the signal generator, testmeter and gain control to the receiver as described in para. 11 (1) to (3).
- (2) Inject into the receiver a 0.1V CW signal at a frequency of 209 Mc/s. Tune the receiver to this frequency.
- (3) Set the gain control to minimum. The meter indication should be not less than 2.6V.

Capacitance of output capacitor

15. The under-mentioned items of equipment are required when checking the capacity and leakage of the output capacitor C53:—

- (1) 20V battery.
- (2) 0–250 microammeter.
- (3) Key switch.
- (4) 100,000-ohm resistor.

16. The capacitor is tested as follows:—

- (1) Connect the positive terminals of the 20V battery and the microammeter to the receiver chassis.
- (2) Connect the negative battery terminal in series with the key switch to the + OUTPUT socket of the receiver.
- (3) Connect the negative terminal of the meter in series with the 100,000-ohm resistor to the +OUTPUT socket.
- (4) Close the key switch for a period of *one minute*. A meter reading of 200 μ A should be obtained.
- (5) Open the switch at the end of *one minute*. The time taken for the meter reading to fall to 50 μ A should be not less than *five seconds*.

If the meter reading falls to 50 μ A in less than the time stated, the capacity of C53 is low, or its leakage is high.

IF alignment

17. Valve changes will not necessitate re-alignment of the IF amplifier.

18. A signal generator Type 106 must be used to align the IF stages. Set up the equipment as follows:—

- (1) Remove the oscillator valve V3 from the receiver.

(2) Connect the output lead of the signal generator Type 106 to the IF and E sockets on the receiver. Either the 70 or 100-ohm output of the signal generator may be used; the output lead must be correctly terminated by a 70 or 100-ohm resistor connected across the IF and E sockets.

(3) Connect a testmeter Type D, set to the 15V DC range to the receiver test points X9 and X11 (positive to X11).

Note . . .

These test points are at HT.

(4) Set the receiver gain control to 1,000 ohms resistance and plug the control into the GAIN CONTROL socket on the receiver.

(5) Switch on and allow the receiver to warm up.

19. The IF coils are numbered 1 to 6, No. 1 being nearest to the front panel. Inject a signal of sufficient amplitude to give a dip on the test meter and adjust the IF trimmers for maximum dip as indicated below:—

(1) Adjust trimmers 1 and 6 at a frequency of 11 Mc/s.

(2) Adjust trimmers 3 and 5 at a frequency of 13.2 Mc/s.

(3) Adjust trimmers 2 and 4 at a frequency of 9.2 Mc/s.

20. Observe the response curve over the frequency range 9.2 to 13.2 Mc/s, ensuring that the output of the signal generator is constant at all frequencies. If the response is not symmetrical about a centre frequency of 11.2 Mc/s, adjust trimmer No. 6 until a symmetrical response curve is obtained.

Trimmer No. 1 may also be adjusted if a symmetrical response cannot be obtained by adjusting trimmer No. 6 alone.

Test point voltages

21. The emission of all valves except the diodes V4, V8 and V11 may be checked by measuring the voltages at the test points on the front panel of the receiver.

22. Typical test point voltages are shown in Table 1. All voltages are measured on a testmeter Type D set to the range indicated. The table shows the permissible limits of voltage between the positive test point X11 and each of the remaining test points with no signal and the receiver gain control set to maximum except where stated otherwise.

Valve electrode voltages

23. Voltages at the electrodes of the valves measured by a testmeter Type D connected between the valve electrode and earth are given in Table 2. Anode and screen voltages are measured with the testmeter set to the 750V DC range. Cathode voltages are measured with the meter set to the 15V DC range.

TABLE 2

Receiver Type R.3684—valve electrode voltages

Valve	Anode V ($\pm 30\%$)	Screen V ($\pm 30\%$)	Cathode V ($\pm 30\%$)
V2	230	240	2.0
V3	200	—	0
V5	150	210	1.7
V6	150	210	1.6
V7	150	210	1.6
V9	150	210	1.6
V10	150	210	1.6
V12	90	190	0.9
V13	290	—	6.2

AMPLIFIER TYPE A.3687

24. Tuning of the RF unit Type 149 is critical (one complete turn of the capacitors covers the entire IFF Mk. 3G frequency range) and the capacitors C5, C10 and C20 must be carefully adjusted with the trimming tool provided.

25. The operations described below are made in conjunction with a receiver Type R.3684, the performance of which is known to be up to specification. The tests should preferably be made using the receiver with which the amplifier will normally be working.

TABLE 1

Receiver Type R.3684—test point voltages

Test point	Valve	Test meter range	Voltage limits	Remarks
X2	RF amplifier	V2	15V DC	1.0–1.6
X3	Local oscillator	V3	15V DC	4.0–6.0
X4	1st IF	V5	15V DC	1.6–2.4
X5	2nd IF	V6	15V DC	1.6–2.4
X6	3rd IF	V7	15V DC	1.6–2.4
X7	4th IF	V9	15V DC	1.6–2.4
X8	5th IF	V10	15V DC	1.6–2.4
X9	Video amplifier	V12	15V DC	4.0–6.0
X10	Output	V13	15V DC	0.4–0.6
X11	HT rectifier	V14	750V DC	260–320

gain at minimum
between X11 and
chassis

RF coverage

26. To determine the RF coverage, set up the amplifier and test equipment as follows:—

- (1) Connect the output plug of the amplifier to the RF INPUT plug of the receiver Type R.3684, using a length of Uniradio 21 cable terminated at each end by a suitable socket.
- (2) Connect a bench gain control consisting of a 3,000 ohm log-law variable resistance to the REMOTE GAIN socket of the receiver.
- (3) Connect a testmeter Type D, set to the 15V DC range, to test points X9 and X11 of the receiver. (Positive terminal of the testmeter to X11).
- (4) Connect the output lead of a signal generator Type CT53 to the input plug of the amplifier.

27. Check the RF coverage as follows:—

- (1) Inject a 200 Mc/s CW signal into the amplifier, and by adjusting the three capacitors, check that the tuned circuits will peak through this frequency.
- (2) Tune the receiver to a frequency of 210 Mc/s and repeat the test detailed in sub-para. (1) at this frequency.

Gain

28. The gain of the RF unit is checked by setting-up the equipment as described in para. 26. Then proceed as follows:—

- (1) Inject a CW signal at a frequency of 200 Mc/s into the amplifier. Tune the amplifier and receiver to this frequency.
- (2) Set the signal generator attenuator and receiver gain control to give a deflection of between 2 and 5V on the testmeter. Note the reading.
- (3) Disconnect the amplifier and inject the signal directly into the receiver.
- (4) Increase the signal by 25 dB. The deflection on the meter should not be less than the reading obtained in (2).
- (5) Repeat the above tests at a frequency of 210 Mc/s.

29. The actual gain is determined by carrying out the operations described in para. 28 and noting the amplitude of signal required in sub-para. (4) to give the same output reading as that obtained in sub-para. (2). The gain may then be derived from the following formula:—

$$\text{Gain (in. dB)} = 20 \log_{10} \frac{V_2}{V_1}$$

where V_1 = signal input to amplifier to give a certain output and V_2 = signal input to receiver to give the same output.

30. Suppose for example that the output of the signal generator was increased from $5\mu\text{V}$ to $100\mu\text{V}$ to obtain the same output with the amplifier in and out of circuit respectively, then the gain would be:—

$$\begin{aligned} \text{No. of dB} &= 20 \log_{10} \frac{100}{5} \\ &= 20 \log_{10} 20 \\ &= 20 \times 1.3010 \\ &= 26 \text{ dB approx.} \end{aligned}$$

31. The measured gain of the amplifier should be approximately 25 dB.

Signal-to-noise ratio

- 32.** (1) Set up the amplifier, receiver, gain control and signal generator as described in para. 26, sub-para. (1), (2) and (4).
- (2) Connect the +OUTPUT socket of the receiver to the A1 terminal of an oscilloscope Type 13A. Set the Y PLATE SELECTOR of the oscilloscope to A1A2. Turn the A1 gain control to maximum.
- (3) Inject into the amplifier a square-wave-modulated signal of approximately $32\mu\text{V}$ at a frequency of 200 Mc/s. Tune the amplifier and receiver to this frequency, by reference to the trace on the oscilloscope.
- (4) Switch off the carrier from the signal generator. Adjust the receiver gain control to give 1 cm. of noise on the oscilloscope trace.
- (5) Switch on the carrier and adjust the attenuator on the signal generator to give a total deflection of 2 cm. on the oscilloscope. The attenuator reading for this condition should not exceed $3.2\mu\text{V}$.
- (6) Repeat the operations detailed in sub-para. (3) to (5) at a frequency of 210 Mc/s.

Test voltages

33. The limits of voltage between each test point of RF unit Type 149 and earth, measured by a test meter Type D set to the 15V DC range are shown in Table 3.

TABLE 3
Amplifier Type A.3687—test point voltages

Test point	Voltage
X1	1.4–1.7
X2	1.4–1.7
X3	1.8–2.2

34. Total HT voltage measured by a testmeter Type D set to the 750V DC range should be within the limits 252 to 308V. The meter is connected between the smoothing choke (L1) in power unit Type 862 and earth.

MODULATOR TYPE 239

35. The following checks may be made on this unit:—

- (1) Connect a CRT monitor to the PULSE CURRENT $v/5$ AMPS test point.

- (2) Check the delay of the main pulse out from the trigger. This is nominally $40\mu\text{s}$.
- (3) With the main HT off, transfer the CRT monitor to the PULSE SHAPE V6 GRID test point and check the waveform. This should be substantially rectangular with no degradation of the trailing edge.

Note . . .

If the waveform is unsatisfactory, the PULSE ONSET control R19 should be adjusted to reduce the pulse duration. However, the pulse duration should not be reduced to less than $22\mu\text{s}$: the normal setting is between $22\mu\text{s}$ and about $30\mu\text{s}$ (at which setting the trailing edge of the pulse begins to change).

- (4) With the main HT still off, and the CRT monitor still connected to the PULSE SHAPE V6 GRID test point, check that the PRF divider is working by throwing the appropriate switch, whereupon the pulse will be underlined.
- (5) Transfer the CRT monitor to the PULSE CURRENT V/5 AMPS test point, switch on the main HT and observe the pulse current. The pulse duration is nominally $2\mu\text{s}$ with an amplitude of 81V.
- (6) Check the operation of the switching relay by throwing the IFF switch in the operations room on and off.
- (7) Check the operation of the thermal relay by switching off the modulator and then switching it on with the EHT TRANS switch in the ON position. The red HT lamp should indicate the delay by lighting after an interval of *one minute*

TRANSMITTER TYPE T.3686

Tuning

36. The following paragraphs describe the procedure for tuning the transmitter when fitted in the apparatus rack.

Note . . .

Before carrying out the preliminary tuning operations, ensure that the IFF switch on the control panel Type 621 is off and that the modulator Type 239 is switched off.

37. Set up as follows:—

- (1) Disconnect all leads from the front panel of the transmitter. Remove the transmitter from the rack and withdraw the dust cover from the chassis and panel.
- (2) Set the tuning controls as indicated:—
 - (a) Anode lines. Position the shorting bar half-way along the lines.
 - (b) Output capacitor (C5). Set three-quarters open.
 - (c) Filament capacitors. Screw in to the limit, then unscrew one and a half turns.
 - (d) Aerial tap. Position 0.6 in. from the short-circuited end of the output lines.
 - (e) Output lines. Set screw adjustment of coupling to anode lines to the fully-out position.
- (3) Replace the transmitter (without the dust cover) in the rack.

- (4) Connect all leads except the pulsed HT feed to the appropriate plugs or sockets.
- (5) Ensure that the cable-mounted changeover socket on the junction box is connected to the G-band plug (PL3).
- (6) Switch on the mains supply to the IFF rack by closing the IFF switch on the control panel Type 621.

38. To tune the transmitter to a frequency of 209 Mc/s proceed as follows:—

- (1) Close the mains switch on the transmitter. The valve filaments will light and the blower motor will start.
- (2) Set the LOCAL REMOTE switch to the LOCAL position. The control relay will now operate.
- (3) Connect the aerial feeder to the OUTPUT plug on the transmitter. Connect the HT input lead to the HT INPUT socket.
- (4) Switch on the modulator Type 239 and operate the EHT TRANS switch on the modulator.
- (5) Adjust the output capacitor (C5) and the filament capacitors (C3 and C4) in the IFF transmitter for maximum meter reading on the P-meter. It should be possible to tune through a clearly defined maximum in all instances.
- (6) Set up a wavemeter Type W.1649 at a distance not greater than 6 ft. from the transmitter. Measure the transmitter frequency. If this has an error greater than ± 0.2 Mc/s, switch off the pulsed HT and adjust the anode circuit shorting bar. A movement of $\frac{1}{16}$ in. will result in a frequency change of approximately 1 Mc/s. Move the shorting bar towards the anodes to increase the frequency, and away from the valves to decrease the frequency.
- (7) Apply the pulsed HT and re-adjust the output and filament tuning capacitors. Measure the transmitter frequency. When this is approximately correct, a measurement should be made with the dust cover fitted in position, and with the minimum coupling between the anode and output lines.
- (8) Repeat the procedure until the frequency is between 207 Mc/s and 211 Mc/s. It is essential that the output and filament capacitors are adjusted for maximum output after each adjustment to the anode circuit shorting bar.
- (9) Final adjustment of frequency can be made by tuning the filament capacitors. This will not alter the power output to any appreciable extent. The output capacitor can be adjusted through holes in the side and top of the dust cover.

Pulse width

39. The pulse width is measured on a monitor Type 61 after the transmitter has been tuned as described in para. 38. Then proceed as follows:—

- (1) Connect the two MONITOR sockets on the transmitter to the SYNC and DC PULSE sockets on the monitor.
- (2) Set the Y AXIS switch on the monitor to DC PULSE, the SYNC switch to POS., and the TIME-BASE switch to FAST.

- (3) Measure the width of the pulse on the monitor CRT. The width of the main portion of the envelope should be between 1.8 and 2.2 μ s.

MONITOR TYPE 61

Removing the CRT

40. (1) Disconnect the deflector coils by disengaging PL5 from SK1. The plug and socket are positioned at the left-hand side of the chassis.
- (2) Loosen the knurled-head nut at each side of the CRT mounting bracket.
- (3) Slide the complete CRT assembly to the rear.
- (4) Undo the three captive screws which clamp the deflector coil assemblies to the mu-metal shield, and remove the two coil assemblies.
- (5) Lift the screen end of the CRT and shield clear of the chassis. (The CRT and shield will pivot about the rear mounting). Tighten the two knurled-head nuts.
- (6) Withdraw the CRT forward from the mu-metal shield.
41. The above procedure is reversed when fitting a new CRT.

RF tuning

42. The RF pulse circuit is set up as follows:—
- (1) Connect the output of a signal generator Type CT53 to the RF PULSE socket on the monitor.
- (2) Remove the cover from the RF box, and connect the probe of an oscilloscope Type 13A to the output terminal of the RF rectifier (end of L10).
- (3) Set the PROBE SELECTOR to A1, the Y PLATE SELECTOR to AIHF, and the A1 gain control on the oscilloscope to maximum.
- (4) Inject a modulated signal at frequency of 172 Mc/s and of maximum amplitude into the RF unit. Adjust the PULSE TUNING capacitor on the monitor until the modulation waveform appears on the oscilloscope CRT.
- (5) Adjust the input tap on the tuned circuit to give a maximum signal, retuning the circuit after each adjustment.
- (6) Replace the screening cover on the RF unit.
- (7) Check that the RF circuit will tune through a frequency range of 150 to 260 Mc/s.

Trace axes

Vertical axis

43. The trace axes are positioned by adopting the following procedure:—
- (1) Remove the gas-filled relay V3 from the monitor.
- (2) Set the Y AXIS switch to DC PULSE and the TIMEBASE switch to SLOW.
- (3) Apply 230V AC between the DC PULSE socket and earth. A trace will appear on the CRT screen.

- (4) Slacken the three knurled nuts at the rear of the CRT base and adjust the CRT until the trace is vertical within 2 deg.
- (5) Lock the CRT disconnect the 230V AC supply, and replace V3.

Horizontal axis

44. (1) Inject a pulse having a repetition frequency of 50 derived from a test set Type 403 into the SYNC socket of the monitor.
- (2) Slacken the three screws which hold the CRT shield in position. (These screws engage in pillars attached to the shield). Adjust the shield and deflector coil assembly until the trace is horizontal within 2 deg.

Performance tests

Timebase speed

45. Before carrying out the following tests the dust cover must be removed from the oscilloscope Type 13A. This necessitates disconnecting the mains lead which must be re-connected after the dust cover has been removed.
46. Set the oscilloscope controls as follows:—
- (1) CALIBRATION MARKERS to 10 μ sec.
- (2) FLYBACK to one quarter clockwise rotation.
- (3) SYNC to 50 c/s.
- (4) AMPLITUDE to mid-position.
- (5) VELOCITY to 1 kc/s.
- (6) FINE VELOCITY to 5.
- (7) SYNC AMPLITUDE fully counter-clockwise.
- (8) Y PLATE SELECTOR to AC.

47. Then proceed as follows:—

- (1) Connect the SYNC socket on the monitor to pin 4 of V5 in the oscilloscope, and the DC PULSE socket on the monitor to the wiper of S5C (output of the calibration circuit) in the oscilloscope.
- (2) Set the Y AXIS switch on the monitor to DC PULSE. Four pips should appear on the monitor CRT, giving a timebase of 30 μ s. Note accurately the relation of the end pips to the vertical lines on the perspex mask.
- (3) Set the Y AXIS switch to 500 KC TIMING. Without altering the HORIZONTAL SHIFT control it should be possible to adjust the trimmer on the top of the oscillator cam so that 15 cycles appear on the monitor CRT in the space previously occupied by three complete marker cycles.

Sweep duration

48. The duration of the fast and slow timebase sweeps is checked as follows:—
- (1) Inject a pulse having a repetition frequency of 50, derived from test set Type 403, into the SYNC socket on the monitor.
- (2) Set the Y AXIS switch on the monitor to 500 KC TIMING.

The duration taken between the outer lines of the graticle should be 11–28 μ s on fast range and 22–56 μ s for slow range.

Test voltages

49. The permissible limits of voltage at various positions in the circuit of the monitor are shown in Table 4. All voltages are measured with a test-meter connected between the position indicated and earth. EHT supply is measured on an electro-static voltmeter. All other measurements are made on a testmeter Type D1 set to the range indicated in the table

TABLE 4
Monitor Type 61—EHT and HT voltages

Position in circuit	Test meter	Reading	Position of Timebase switch
Junction of R35 and C25 (EHT)		2.25kV $\pm$ 10%	
Junction of L5 and C13 (HT)	480V DC	430V $\pm$ 10%	
V1 anode	120V DC	6	FAST AND SLOW LINE
V1 screen	480V DC	110	
V2 anode	120V DC	13	
V2 screen	1200V DC	160	
V3 anode	1200V DC	400	
V3 cathode	480V DC	35	
V3 cathode	480V DC	50	
V4 anode	1200V DC	320	
V4 anode	1200V DC	350	
V4 screen	480V DC	40	
V4 screen	480V DC	90	FAST AND SLOW LINE

SWITCH UNIT TYPE 271

50. Each switch unit is individually calibrated. The calibration is critical and depends on the position of the coils, which should not be moved or deformed in any manner. Should a coil be moved or damaged, the calibration of the unit must be checked.

Calibration

51. Before calibrating a switch unit an adaptor must be made up locally to enable the signal generator to be connected to the switch unit. The most convenient method is to use an adaptor made from a socket Type 525 (Stores Ref. 10H/-3931) and a socket Type 579 (Stores Ref. 10H/4953) as indicated below:—

- (1) Remove the ferrules and ferrule nut from the socket Type 523. These are not required.
- (2) Remove the connecting spill from the socket Type 523 and solder the spill to the tag of the socket Type 579.
- (3) Solder the bodies of the two sockets together. Replace the top and the insulator of the socket Type 523.

52. The switch unit should be calibrated as follows:—

- (1) Connect the signal generator through the adaptor described above to the AERIAL plug PL1 on the switch unit. Connect TRANSMITTER output PL3 of the switch unit to a detector unit Type 73, using the lead provided with the detector unit.
- (2) Screw in the R-gap stub to the limit. Tune the signal generator to a frequency of 210 Mc/s and inject the maximum CW signal into the switch unit.
- (3) Adjust the T-gap stub for minimum reading on the detector unit. Note the dial reading on the switch unit. It should be possible to read the position of the screw correct to one-tenth of a turn.
- (4) Repeat the above procedure at intervals of 10 Mc/s over the frequency range 210 to 150 Mc/s.
- (5) Screw the T-gap stub two turns further out than the position determined in (4) for a frequency of 150 Mc/s.
- (6) Short circuit RECEIVER plug PL2 on the switch unit with the blank socket provided with the detector unit. Set the signal generator to a frequency of 210 Mc/s.
- (7) Adjust the R-gap stub for minimum reading on the detector unit. Note the dial reading.
- (8) Repeat the operations in (7) at intervals of 10 Mc/s over the frequency range 210 to 150 Mc/s.

Spark gaps

53. The spark gaps may be detached after removing the screw at the earthy end of each gap, and loosening the screw in the junction block. Moisture on the spark gaps should be wiped off with a clean rag.

Coiled lines

54. In very damp climates water may condense between the turns of the coiled lines. The water should be removed with an air dryer.

MATCHING UNIT TYPE 28**Insulation resistance**

55. The insulation resistance of the matching unit is tested as follows:—

- (1) Remove the screw at the end of the unit remote from the coaxial plug, and insert a thin sheet of mica between the inner line and the outer trough at this point.
- (2) Measure the insulation resistance on a megger connected across the pins of the 2-pole plug. The resistance should be not less than 40 megohms when tested at 500V DC.

Continuity

56. With the insulating sheet in place (*para.* 55) there should be continuity between the right-hand pole of the two-pole plug and the centre pole of the coaxial plug.

Dismantling

57. To dismantle the units:—

- (1) Remove the two-pole plug, with the exception of one insulator that cannot be detached.
- (2) Remove the four screws in the sides of the unit adjacent to the coaxial plug. Remove the screw at the opposite end. Lift out the complete inner line.
- (3) Remove the four screws in the end plate carrying the coaxial plug. Unscrew the end plate and plug. (It may be necessary to insert the blade of a knife under the neoprene washer if it should stick to the metal).
- (4) Slacken the lock-nut on the inner line, and unscrew the central conductor from the plug at the end of the tube. The central conductor may now be withdrawn from the tube.

AERIAL ARRAY

58. The aerial rods Type 288 and 345 and the aerial frame Type 107 should be mechanically checked.

59. Each of the aerial rods should be removed and a check made to ensure that they are clean. In the instance of the aerial rods Type 288, a check should also be made to ensure that the conical metal inserts are clean. XG275 low-temperature grease should be used to grease the threads of the aerial rods before they are replaced in their sockets.

60. A check should be made that the aerial mounting boxes are serviceable, and their insulation resistance checked. If they show any signs of deterioration proceed as follows:—

- (1) Remove the complete mounting assembly from the aerial framework.
- (2) Unscrew the woodscrews which hold the mounting plate to the wooden box and remove the mounting plate.
- (3) Unscrew the wood screws which hold the plastic plate on the mounting to the box and break the joint.
- (4) Clean and dry the components, leaving the parts in a warm place until they are completely dry.
- (5) Reassemble and tightly screw down the various components, sealing the joint between box and plastic unipole mount with Bostik.
- (6) Coat the exterior of the box with a thick coat of Varnish Special V130/1 giving special attention to the joints of the box and joints between components, screws etc. Allow to dry and reassemble.

PIVOT MOUNT**Pivot and gearbox**

61. The oil system has a capacity of approximately 17½ gallons when filled to the level of the overflow; approximately 6 gallons of oil are retained in the gearbox, 5 gallons in the main drive and 6 gallons in the sump.

62. Under normal working conditions and in the absence of leakage at any of the seals, the oil level should not require topping up more frequently than about once in six months though it should be checked at three-monthly intervals by the method described below.

Note . . .

The following check should be carried out only after the aerial head has been turning for at least ten hours. This allows the gear box to become warm and so decreases the viscosity of the oil.

- (1) Set the safety switches to SAFE.
- (2) Remove the oil filler plug from the filler hole on the pivot mount gear box in the cabin. Pending the carrying out of a modification in which a filler plug drilled with an air hole is to be fitted, this allows air to be drawn into the pivot mount as any surplus oil is drained away.
- (3) Remove the oil overflow plug (*fig. 27 in A.P.2527B, Vol. 1, Part 1, Sect. 2, Chap. 2*) from the base of the pivot mounting in the plinth and allow any oil which has accumulated in the sump oil level pipe to drain away into a suitable receptacle. If the pivot mount contains the correct amount of oil, approximately a quarter of a pint of oil should drain from the sump level pipe.

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- (4) If the amount of oil that drains from the sump level pipe exceeds a quarter of a pint, this indicates that the pivot mount has been overfilled with oil and a minimum of *thirty minutes* should be allowed for the surplus oil to drain away through the sump oil level pipe and into the receptacle. The oil overflow plug and the oil filler plug should then be replaced as the pivot mount now contains the correct amount of oil.
- (5) If the amount of oil which drains from the sump level pipe is less than a quarter of a pint the pivot mount should be topped up with oil as follows:—
 - (a) Add about half a gallon of Type OC-160 oil *every thirty minutes* until oil begins to flow from the sump level pipe, into the receptacle beneath. The thirty-minute intervals are necessary to allow the added oil to percolate through the system.
 - (b) When oil appears at the outlet of the sump level pipe, no further oil is to be added and a *further thirty minutes* is to be allowed for any surplus oil to drain away before the oil overflow plug is screwed into place.
 - (c) Replace the oil filler plug on the gear box and wipe up any surplus oil in the vicinity.
 - (d) Reset the safety switches in the cabin and plinth to UNSAFE.

63. From the above description it follows that the inspection port in the casting of the pivot mount in the Cabin is of no significance in determining whether or not the correct amount of oil is contained in the pivot mount. Furthermore, a small amount of oil may be trapped immediately behind the glass and thus give a false impression of the oil level. However, when the aerial head is rotating at 6 r.p.m. an indication of the satisfactory functioning of the oil pump can be gained by checking, *after about five minutes* running, that a continuous film of oil is being splashed against the glass of the inspection port.

64. Any flow of oil from the self drain cock (*fig. 27 in A.P.2527B, Vol. 1, Part 1, Sect. 2, Chap. 2*) indicates that the inner felt seal between the fixed and rotating parts of the pivot mount assembly is breaking down probably due to pressure caused by overfilling the system with oil. When the surplus oil is drained off through the sump level pipe the felt seal should return to its normal condition. Any oil which remains in the air chamber should be cleaned out by removing in turn the eight circular plates on the pivot mount octagonal base plate in the plinth.

65. From time to time the oil level in the gear box assembly Type 50 should be checked, since in the event of the oil seal at the base of this assembly becoming defective, the oil will drain away back to the sump. As a result, not only may damage be caused to the gearing due to lack of lubrication, but also when the procedure, described above, for checking the oil level is followed, the false impression

will be given that the pivot mount has been overfilled with oil.

66. The oil in the gearbox is at its correct level when the oil just reaches the teeth of the gear immediately below the oil filler hole. This can be checked by visual inspection through the filler hole, using an electric torch for illumination. To avoid overfilling if the level is found to be low, any surplus oil in the sump should be drained off from the sump level pipe into a clean receptacle and transferred to the gearbox before any new oil is added to restore the correct oil level. The transfer of oil from sump to gearbox should be repeated as often as is required, according to the rate at which it drains away but no further new oil should be added.

Slip-ring unit

67. This unit may be serviced as follows:—

WARNING

Before carrying out the following operations, first ensure that all power supplies are switched off in the plinth and that the mains circuit breaker in the switch room is isolated.

- (1) Remove the cover from the slip-ring unit.
- (2) Check that all slip-rings are clean. If necessary, remove any accumulation of carbon dust from all rings and spacers, using a soft rag moistened with gasoline no-lead (Stores Ref. 34C/175) Carbon dust is a likely cause of low insulation resistance and will result in flash-over.
- (3) Ensure that brush tensions and brush lengths are in accordance with the figures given in Table 5.

TABLE 5
Slip-ring unit-brush tensions and lengths

Brush	Tension	Minimum length
5 amp.	4 to 6 oz.	$\frac{11}{16}$ in.
30 amp.	15 to 20 oz.*	$\frac{11}{16}$ in.
100 amp.	20 to 30 oz.	$\frac{11}{16}$ in.

*After incorporation of CA511

- (4) If necessary, extend the brush springs to increase their tensions to within the ranges quoted in Table 5.
- (5) If the existing brushes are too short, fit new brushes and ensure that they are correctly bedded in. The procedure is as follows:—
 - (a) Pass a strip of No. 0 or 00 sandpaper repeatedly between the face of the brush and the surface of the slip-ring. Ensure that the sandpaper is held firmly against the circumference of the slip-ring for at least 180 deg. Use the normal brush pressure, and when drawing the sandpaper back, raise the brush so that it does not make contact with the paper.

- (b) Rotate the cabin for a period of approximately fifteen minutes. This will improve the surface of the brushes.
- (c) When the brushes appear to make a good fit (that is, approximately 80 per cent. of the surface area of the brush is in contact with the slip-ring) remove one brush from the holder and examine to ensure that a good surface has been obtained.
- (6) Check the freedom of action of the brush springs and ensure that they do not foul their holders. The position of each holder should be such that the brush is positioned centrally on its slip-ring.
- (7) Remove each brush and measure the insulation resistance between the slip-rings and earth. This should be not less than 50 megohms when tested at a potential of 500V DC.
- (8) Replace all brushes in their holders.
- (9) Using a testmeter Type D, check the resistance between each brush holder and its slip-ring. This may vary but should not be greater than 0.2 ohm for silver carbon brushes, 2 ohms for copper carbon brushes, and 15 ohms for carbon brushes.
- (10) Replace the cover on the slip-ring unit.

Cleaning the air filter

68. The procedure is as follows:—

- (1) Lift the cowl covering the filter.
- (2) Undo the bolts securing the sand louvre and remove the filter.
- (3) Rinse the filter in gasoline no-lead (Stores Ref. 34C/175) in the cleaning tank provided. If this gasoline no-lead is not available, normal unleaded M.T. fuel may be used as the detergent.
- (4) Re-charge the filter by immersing it in the cleaning tank in:—
 - (a) Oil OM-36 (Stores Ref. 34D/241) in temperate regions.
 - (b) Oil OM-13 (Stores Ref. 34D/293) in arctic regions.
 - (c) Oil OM-270 (Stores Ref. 34A/32) in tropical regions. When stocks of oil OM-270 are exhausted, use oil OMD-330 (Stores Ref. 34D/240).

Selsyns

69. Selsyns normally require no servicing. The brushes and bearing grease should last for the whole life of the equipment.

70. When operated under severe climatic conditions, the selsyns should be dismantled and examined for internal corrosion. When re-assembling it must be ensured that the brushes are re-fitted in precisely the same position and are the same way round as when originally fitted.

OVERALL CHECK ON AERIAL HEAD

Mechanical

71. Assuming that the slip-ring unit has been serviced as detailed in para. 67, the following procedure may be adopted to make a mechanical check on the aerial head:—

- (1) Set the three-position function selector switch on the control unit (training) Type 620 (on the rack assembly Type 330 in the transmitter well) to POSITION.
- (2) In the plinth, switch off the amplidyne and cabin power supplies and open the safety switch.
- (3) In the cabin, open all switches on control panel Type 621.
- (4) Place a spirit level, calibrated in $2\frac{1}{2}$ minute divisions, on the base plate of the pivot mount.
- (5) With the cabin turned to 0 deg. as indicated on the dial above the gearbox, pack the spirit level until the bubble appears in the middle of the scale.
- (6) Rotate the cabin, stopping every 30 deg., and record the spirit level readings. The total variation through 360 deg. should not be more than 15 minutes.

Note . . .

The spirit level must be placed so that it points from back to front of the cabin.

- (7) Check that when the cabin locking device is in the locked position the cabin cannot be rotated manually.

Lubrication

- 72.** (1) Remove the cover nut from the oil overflow outlet at the bottom of the pivot mount.
- (2) Top up the sump with oil OC-160, through the filler cap in the gearbox until a trickle of oil comes through the overflow outlet. This will indicate that there is sufficient oil in the sump.

Note . . .

As the oil takes a considerable time to pass through the gearbox into the sump, only a small quantity of oil (e.g. half a gallon) should be poured in and the head left for 30 minutes before inspection of the overflow. When oil appears at the outlet, no further oil should be added and a further 30 minutes allowed before the overflow is closed.

- (3) Inspect the inside and outside of the cabin for oil leaks.
- (4) Remove the inspection cover from the cable outlet elbow at the base of the pivot mount.
- (5) Examine the cables thus revealed for any trace of oil.
- (6) If necessary, clean the cables with gasoline no-lead.
- (7) Replace the inspection cover.
- (8) Remove the inspection port nearest to the air equalizing vent at the base of the pivot mount.
- (9) Examine for any traces of oil.

- (10) If oil is found to be present, clean out the compartment with a cleaning rag.
- (11) Inspect the other ports and clean if necessary.

Electrical

73. The following procedure may be adopted to make an electrical check on the head:—

- (1) Switch on the cabin power supplies and set the cabin safety switch in the plinth to the **SAFE** position.
- (2) On the control panel Type 621, set the main ON/OFF switch to ON. After a time interval dependent on the cabin humidity, the *red* indicator lamp on the control panel Type 621 should light.
- (3) Check that, after a period of approximately one minute, the *green* lamp on the rectifier unit Type 67 lights, indicating the presence of the 200V DC supply.
- (4) Close the switch labelled **IFF EQUIPMENT** on control panel Type 621.
- (5) Switch on the filaments of the transmitter Type T.3686 and switch the **LOCAL/REMOTE** switch to **LOCAL**.
- (6) Switch on the modulator Type 239 and note that, after one minute, the *red* lamp on the panel lights.
- (7) Switch the transmitter **LOCAL/REMOTE** switch to **REMOTE** and note that the *red* lamp is extinguished.
- (8) On the monitor console, set the head selector switch in the appropriate position, close the G-band key and check that the *red* lamp on the modulator Type 239 lights.

Note . . .

IFF keys on all other consoles should be switched off.

- (9) Check that the transmitter is firing by the P-meter reading.
- (10) Connect the monitoring point on the transmitter to the RF input on the monitor Type 61 and tune to give a satisfactory picture.
- (11) Check the width of the pulse; this should be $2\mu\text{s} \pm 0.2\mu\text{s}$.
- (12) Using a wavemeter Type W.1649, check the frequency of the transmitter. This should be between 207 Mc/s and 211 M/cs.
- (13) Check that the spark gaps on the switch unit Type 271 are ionized satisfactorily.
- (14) Connect the RF output of a signal generator Type CT53, set for sine-wave modulation, to the input of the receiver Type R.3684.
- (15) Connect the output of the receiver Type R.3684 to the monitor Type 61.
- (16) Connect a test lead from the **GAIN CONTROL** socket on the receiver to SK17 on the junction box Type 367.
- (17) Set the **LOCAL GAIN** control, on the junction box, to give a suitable signal on the monitor Type 61.
- (18) Sweep the signal generator Type CT53 through 209 Mc/s and note that maximum signal is obtained at this frequency.
- (19) Disconnect the signal generator and reconnect the aerial and the remote gain control.

74. At this stage, all portable test equipment should be removed from the cabin. The cabin safety switch should be put to **SAFE** and the Selector switch on the control unit (trg) Type 602 put to **LOCAL**. The hand turning interlock should be closed and the cabin doors secured. The checking may then be continued as follows:—

- (1) Switch on the amplidyne, and set the safety switch in the plinth to **UNSAFE**.
- (2) Return to the cabin and put the safety switch in the cabin to **UNSAFE**.
- (3) Wait until the cabin settles in its controlled position, then rotate the turning handle on the control unit and note that the readings in degrees increase as the cabin is azicated in a clockwise direction. Rotate the turning handle quickly in steps of 20 to 30 deg. and check that the correct operation of the slew circuits prevents any harshness in the servo system and that the cabin does not do more than one overshoot followed by a minor undershoot, before coming into its rest position.

Note . . .

The amplitude of overshoot will vary depending on wind conditions but, at any selected bearing, there must be no tendency for the aerial head to "creep" when taking up its new position.

- (4) Remove the current limit valve V2 from the servo amplifier Type 297 (on the rack assembly Type 318 in the transmitter well).
- (5) Azicate the aerial head rapidly by rotating the turning handle on the control unit (training) Type 602.
- (6) The magnetic overload in the plinth should operate, the amplidyne supply contactors release and the amplidyne slow down and stop rotating.
- (7) Replace the current limit valve V2 in the servo amplifier Type 297.
- (8) Reset the magnetic overload, put the switch on the control unit (training) Type 602 to **REMOTE** and re-start the amplidyne.
- (9) Set the three-position function selector switch on the control unit (training) Type 620 (on the rack assembly Type 330 in the transmitter well) to **CONT. ROT. CLOCKWISE**.
- (10) On the control unit Type 620, turn the **SPEED** control fully counter-clockwise and note that the speed of rotation, of the cabin is not greater than 1 r.p.m.
- (11) Turn the **SPEED** control on the control unit fully clockwise and note that the speed of rotation is not less than 6 r.p.m.
- (12) Set the function selector switch on the control unit Type 620 to **CONT. ROT. ANTICLOCKWISE** and then repeat operations (10) and (11).
- (13) Set the function selector switch on the control unit Type 620 to the **CONT. ROT. CLOCKWISE** and to the **CONT. ROT. ANTICLOCKWISE** positions alternately.
- (14) Note that the armature current, as observed on the built-in meter on the servo amplifier Type 297, does not peak above 65 amps. during the performance of operation (13).

PART 3

FAULT DIAGNOSIS

PART 4

TESTING AFTER INSTALLATION

Chapter 1

RADAR, TYPE 7, Mk. 2

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Introduction

1. The information in this chapter is extracted from the relevant GCI station test specifications, and is included here for information. The tests herein are normally carried out as part of overall station testing, and details of these tests will be found in the station test specification which is held on the site.

Test equipment required

2. This schedule does not include built-in test equipment in the transmitter well.

- (1) Oscilloscope Type 13A (Stores Ref. 10S/831)
- (2) Signal generator Type CT.53 (10S/16160) or ~~multimeter Type 68 (10S/16370)~~
- (3) Wavemeter Type 1649 (10T/6045)
- ~~(4) Signal Watch (10S/1117)~~
- (5) Calibrated spirit level
- (6) Test Set Type 404 (10S/16159)
- (7) Test kit Type 29A (10S/16868)
- (8) 5 ft. by 2 in. by 2 in. plane surface
- (9) Lines for checking radar Type 7 framework with brackets
- (10) Plumb line
- (11) Tester, insulation resistance Type D (5G/203)
- (12) Multimeter Type 1 (10S/16411) or multimeter (electronic) Type CT38 (10S/16308)
- (13) Test Set 4341 (10S/16626)
- (14) Attenuator Type 113
- (15) Amplifier (IF & vid.) Type A.3680
- (16) Receiver (modified IFF receiver)
- (17) Double-ended F and E sockets, Type JS-1-BHF (10H/19707)

TESTS ON TRANSMITTER T.3705

3. There are two transmitters in the well and the following tests should be applied to both.

Note . . .

For convenience, operations (7), (8) and (9) may be performed at the same time as (4), that is, while modulator dummy load is attached.

- (1) Ensure that the transmitter mains switch located on the transmitter room power board is OFF. Turn interlock switches on switch unit Type 407 to the horizontal position. Withdraw control unit Type 616. Remove RLT. Open right-hand door and connect (via long test leads) a multimeter Type 1 (set to the 100 AC Range) across the heater connector for oscillator valves located on the power unit Type 887. Select the appropriate transmitter undergoing test by means of the transmitter changeover switch in panel control (capacity switch) Type 869.
- (2) Turn transmitter mains switch and fan unit switch to ON. Turn the interlock switches on the switch unit Type 407 to the vertical position. Press the ON button on the panel (meter) Type 863. Allow two minutes for the valves to warm up and check that the heater voltage as indicated on the meter is $160 \pm 20\%$. Adjust the heater Variac if necessary.
- (3) Check all the meter readings on the built-in meter mounted on the left-hand door of the transmitter. These should be:—

Supply voltage	$140 \pm 15\%$ (119 to 161V)
Heater volts	$160 \pm 15\%$ (136 to 184V)
Trigger bias	$450 \pm 10\%$ (405 to 495V)
50V DC	$290 \pm 15\%$ (246.5 to 333.5V)
General power unit	$360 \pm 15\%$ (306 to 414V)
Monitor power unit	$400 \pm 15\%$ (345 to 460V)
Discharger unit	$240 \pm 15\%$ (204 to 276V)
Trigger power unit	$240 \pm 15\%$ (204 to 276V)

Make a note of heater voltage reading to within $\pm 1\%$.

- (4) Depress the OFF button on the panel (meter) Type 863. Turn the interlock switches (GATE and POWER) to the horizontal position. Remove multimeter Type 1. Replace RLT. Close the left-hand door and turn SW3 on the trigger unit to the EXT. position (Normal) and ensure that SW4 is in the TYPE 7 position. With the capacity switch running at 250 c/s and the rack assembly (master trigger)

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operating normally, run up the transmitter on modulator dummy load. With main HT set to 7kV again adjust the heater Variac until the reading on the built-in meter set to heater volts, is the same as that taken under operation (3). Switch off. Substitute dummy load by oscillator. Turn interlock switches (GATE and POWER) to the vertical position.

Note . . .

The DC ON lamp lights as soon as the interlock switches are turned to the vertical position.

Press the ON button on the panel (meter) Type 863. The transmitter should now commence running up as indicated firstly by the illumination of the FILS ON lamp.

- (5) Check that the FIRST DELAY lamp lights and after a period of from 0-66 seconds the VARIAC DOWN lamp indicates.
- (6) Switch to ON the HT switch of the monitoring unit Type 82 and turn RANGE AND CALIBRATION SWITCH to the 2.5M range. After a period of approximately one minute check the operation of the FOCUS, BRILLIANCE, SWEEP-LENGTH and X SHIFT controls.

Note . . .

The X SHIFT operation is limited to the left-hand side of the screen.

- (7) Switch to ON the CAL switch on the monitoring unit Type 82 and with the MONITOR SELECTOR switch on trigger unit Type 2 to position 2 (TRIGGER OUTPUT), ensure that the waveform display resembles the waveform shown on Part 2, Chap. 2, fig. 16.

Note . . .

This Test should be carried out with transmitter on modulator dummy load.

- (8) Turn MONITOR SELECTOR SWITCH on the trigger unit Type 2 to Position 4 (MAIN THYN. IN VOLTS) and ensure that the waveform display resembles the waveform shown in fig. 16. This Test should be carried out with transmitter on modulator dummy load.
- (9) With the SCAN on the monitor unit Type 82 set to the 2.5M Range measure the duration of the timebase (using the $2\mu\text{s}$ cal. markers that are displayed on the timebases). This should be $30\mu\text{s} \pm 4\mu\text{s}$ (15 cal. markers ± 2 cal. markers). Measure the length of the trace and ensure that it is not less than $2\frac{3}{4}$ in.
- (10) Repeat operation (9) above for the 50M range. The duration should be $50\text{M} \pm 5\text{M}$ (10 cal. markers ± 1 cal. marker). Measure the length of the trace and ensure that it is not less than 3 inches.
- (11) Repeat operation (9) for the 100M range. The duration should be $100\text{M} \pm 10\text{M}$ (20 cal. markers ± 1 cal. marker). Measure the length of the trace and ensure that it is not less than 3 in.
- (12) Repeat operation (9) for the 250M range.

Note . . .

Only the first half of the timebase will have cal. markers displayed on it.

Measure the length of the trace and ensure that it is not less than 3 in. Ensure that there are at least 20 cal. markers on this trace, all of which should be within the first 2 inches.

- (13) Depress the OFF button on panel (meter) Type 863 and turn the interlock switches to the horizontal position. Withdraw control unit Type 616 and replace RLT. Allow the transmitter to remain off for 10 minutes, then run up the transmitter that is, turn interlock switches vertical, etc., ensuring that the HT SET CONTROL on the control unit Type 616 is turned fully counter-clockwise. Depress the ON button and check the following delays. These will be indicated by the lighting of the appropriate lamp labelled:—

FIRST DELAY	on switching on
THIRD DELAY	100 sec. $\pm 25\%$
FIFTH DELAY	200 sec. $\pm 25\%$
RUNNING UP	250 sec. $\pm 25\%$

- (14) Check that the HT ON lamp lights after the RUNNING UP lamp is lit. Ensure that after a period depending on the running up speed of the Variac, the HT UP lamp lights.
- (15) With the control unit Type 616 withdrawn, remove the cover from RLA. Manually depress RLA and ensure that the transmitter trips, the HT ON and HT UP lamps extinguish and ensure that the HT ON and the RUNNING UP lamps light after not more than 90 secs. Check that by depressing RLA manually before the HT UP lamp lights, the transmitter completely switches itself off except for the DC ON lamp. No other lamps should be lit.
- (16) Repeat operation (13) to check the operation of RLE.

- (17) Withdraw trigger unit Type 2 and return control unit Type 616 and proceed to run up the transmitter. Set the EHT to 5kV as indicated on the meter mounted on panel (meter) Type 863 by means of the HT SET CONTROL on the control unit Type 616. Check the following waveform in accordance with fig. 16 of Part 2, Chap. 2, as follows:—

- (a) Main thyatron current
- (b) Line charge volts
- (c) Pulse out volts
- (d) Secondary sync current
- (e) Primary sync current

Note . . .

Use the monitor selector switch on trigger unit Type 2.

- (18) This test should be carried out with transmitter on modulator dummy load. With a trace displayed on the monitor unit Type 82 ensure that the trace remains only on positions EXT. and MSW of SW4 (trigger switch) in trigger unit Type 2. The transmitter should not be triggered on positions 500 c/s or 250 c/s.
- (19) By means of a wavemeter Type 1649 measure the frequency of the transmitter. The frequency should be within ± 0.2 Mc/s of the station operating frequency.

Chapter 1

FAULT DIAGNOSIS

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LIST OF ILLUSTRATIONS

Fault locating chart—automatic control circuits ...	Fig. 1
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TRANSMITTER

General

1. The location of most faults on this equipment can be found rapidly by using the metering and monitoring facilities included in it. Voltages and currents at various test points can be measured, or, alternatively, their absence noted by using the microammeter and selector switch mounted on the left-hand door, reference being made to the limit specified on the switch label. Likewise, most of the more important waveforms can be monitored using the monitoring unit Type 82, and the monitor selector switch on the trigger unit.

2. External monitoring facilities are also available using the external position of the monitor selector switch and by feeding the waveforms to be observed via SK11 on the rear pillar.

3. When servicing or testing the equipment it is sometimes necessary to do so with the units and/or assemblies exposed. The transmitter, therefore must not be left in this condition without proper supervision, even for a short period. Use of the earthing stick provided is essential where there is doubt as to whether the circuit is charged.

WARNING

Extreme care must be taken to avoid accidental contact with any of the supplies, especially the HT or any part of the charging circuit, as these are potentially lethal.

Control circuits

4. Faults in the control circuit can be most readily localized by using the fault-finding chart on fig. 1. This chart checks the control and test circuits and should be followed if a fault is suspected on these circuits or if the transmitter is shut down by the recurrence of a fault.

Cableforms

5. If a cable in a cableform should be found to be faulty, no attempt should be made to remove it. A new cable should be run to replace it, following the old cable run or, where this is difficult, to determine, the most convenient runs of actual cableform. The new cable should be marked with its appropriate number, and the end of the old cable cut back as far as possible and then taped up. The coding used on the cableforms in the transmitter is as follows:—

- (1) Each unit has been given a code number, for example, 20 is the trigger unit.
- (2) Each cable has numbered sleeves fitted which, reading from left to right, indicate:—
 - (a) The unit code number (first two figures).
 - (b) The plug on that unit (middle figure).
 - (c) The pin on that plug (last two figures).

Note . . .

A typical example is the lead 20111 to 05106 which goes from the trigger unit, plug PL1, pin 11 to the power unit (mon.), plug PL1, pin 6.

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There are, however, two exceptions. Where the middle figure is 0 it indicates either

(a) that the lead is terminated in a coaxial plug, in which instance the corresponding socket number is indicated by the last two figures, or

(b) that the lead goes direct to a valve anode, in which instance the last two figures indicate the valve number.

for example, 20014 means trigger unit, SK14.
and 38001 means HT rectifier, V1.

TABLE I
Unit code numbers

Unit Title	Code No.
Transmitter rear pillar	01
Capacitor unit (on transmitter unit Type 174) ...	02
Switch unit Type 407	03
Meter unit (left-hand door)	04
Power unit (mon.) Type 876	05
HT contactor	07
Transformer unit Type 174	08
Resistor panel	09
LT contactor	10
OFF button	11
ON button	12
FILS ON lamp	13
Power unit Type 878	14
HT transformer	15
Discharger unit Type 26	16
Power unit (heaters) Type 887	17
LT Variac	18

TABLE I—continued

Unit Title	Code No.
Power unit (trigger) Type 877	19
Trigger unit Type 2	20
Monitoring unit Type 82	21
Power switch	22
HT UP lamp... ..	23
Fuse (DC ON lamp)... ..	24
HT ON lamp... ..	25
HT Variac	26
Fuse panel (HT Variac)	27
DC ON lamp... ..	28
Rectifier unit Type 26	29
Fuse panel (fans)	30
kV meter	31
Fan (HT compartment)	32
Fan (top left)	33
Fan (top right)	34
HT capacitor	35
HV socket on rear pillar	36
Pulse forming network	37
HT rectifiers	38
Stand-off insulator... ..	39
Stand-off insulator... ..	40
Stand-off insulator... ..	41
Pulse transformer	42
Control unit Type 616	43
Capacitor unit <i>behind</i> control unit Type 616... ..	46
Capacitor unit <i>by</i> pulse transformer ...	47
Capacitor for 32	48
Capacitor for 33	49
Capacitor for 34	50

6. In TABLE 2 are given a list of the fuses contained in the transmitter, together with a brief description of the symptoms resulting should any of them fail.

TABLE 2

Unit	Circuit Ref.	Circuit	Location	Type and Rating	Symptom
Transmitter Cabinet } Cabinet }	FS2 FS3	Primary of LT Variac	Left of LH compartment }	15 A Slyd-lock 15 A Slyd-lock	No filament supply for EHT rectifier, oscillator valves or thyratron.
Transmitter Cabinet } Cabinet }	FS4 FS5	Internal Fans	Right of LH compartment }	5 A Cartridge 5 A Cartridge	None of the three fans will operate.
Transmitter Cabinet } Cabinet }	FS1	DC ON Lamp	Top of LH compartment }	500mA Cartridge	The DC ON lamp will go out.
Power unit Type 876 }	FS1 FS3	Primary of HT trans-former }	On front of panel of power unit }	5 A Cartridge 5 A Cartridge	No HT or filament supply to monitor. No filament supply to control valves in control unit Type 616.
Power unit Type 876 }	FS2 FS4	Primary of EHT trans-former }	On front panel of power unit }	5 A Cartridge 5 A Cartridge	No EHT or filament supply to monitor CRT.
Power unit Type 877 }	FS1 FS2	Primary of transformer }	On front panel of power unit }	5 A Cartridge 5 A Cartridge	Transmitter will not fire. No HT on small thyratron. No filament supply to trigger unit.
Power unit Type 878 }	FS1 FS2	Primary of 50V supply transformer }	On front panel of power unit }	3 A Cartridge 3 A Cartridge	No 50V DC to control unit. Transmitter will shut down.

TABLE 2—continued

Unit	Circuit Ref.	Circuit	Location	Type and Rating	Symptom
Power unit Type 878	FS3 FS4	Primary of HT trans- former	On front panel of power unit	5 A Cartridge 5 A Cartridge	Transmitter will not fire (no HT to trigger unit). No filaments to meter rectifier in PU887 so no reading on AC ranges. See para. 7.
Control unit Type 616	FS1 FS2	Primary of delay chain transformer	On front panel of control unit	5 A Cartridge 5 A Cartridge	

Fuses

7. It should be noted that the fuses on the control unit Type 616 are in the 230-volt AC circuits of this unit. The symptoms resulting from one or both of the fuses blowing will vary with the condition obtaining at the instant the fuse blows. That is,

(1) If the fuses blow during the switching on period before the HT has come on (that is, before relay RLC has closed).

(a) The delay chain will be de-energized and the delay lights will go out.

(b) The Variac will stop, if it has not already reached the minimum HT position.

(c) The FILS ON light will go out.

(d) The auxiliary power supply units and the filaments and heaters of the various valves will stay on.

(2) If the fuses blow during the period when the HT is running up,

(a) The Variac will stop.

(b) The FILS ON and HT ON lamps will go out.

(c) The transmitter will operate on reduced HT until it is switched off. (1) will then apply when it is switched on again.

(3) If the fuses blow after full HT has been reached.

(a) The FILS ON, HT ON and HT UP lamps will go out.

(c) The transmitter will continue to operate at full HT until it is switched off. (1) will then apply when it is switched on again.

8. Thus, if these fuses fail while the transmitter is in use, the replacement of them can be left until the transmitter is switched off again. Alternatively, it is possible to replace the fuses while the equipment is still operating, but if this is done, care should be taken not to come into contact with any live portion of the fuse or fuse holder.

Typical faults

9. Some of the more obscure faults on the transmitter are detailed herein. This list is not exhaustive, but includes some faults which have been found on installation.

(1) *No RF power output, but normal current and voltage readings on oscillator.*

This may be due to bad contact on the oscillator trombone assembly.

(2) *Step on A-scope display in noise.*

This may be due to a faulty CV.2902 spark gap. A defective CV.2902 usually means that the open spark gap will have been arcing over, and this should be inspected, and, if necessary, cleaned. If the assembly is defective and no substitute for it is available the whole spark gap assembly can be completely short-circuited by means of a copper strip. This will result in a slight increase of noise level, but is otherwise satisfactory.

(3) *Intermittent heater supplies to EHT rectifiers, overswing and charging diodes.*

This may be due to the loosening of the heater connection screws in the ceramic valve holders, with the result that the valve holder becomes over-heated and will have to be changed.

(4) *Continuous tripping of transmitter.*

It has been found that, with certain transmitters, there is a tendency for the overload protection circuit to operate, thus causing the transmitter to "trip" when one or other of the switches on the trigger unit Type 2 or monitoring unit Type 82 is adjusted, for example, when the monitor EHT or the calibrator is switched on or when the monitor selector switch is rotated. The cause of this is probably a transient voltage on the HT supply to the trigger unit and, is cured by the incorporation of modification CA593.

By setting the oscillator valves filaments voltage to 17V instead of 16V the tendency for the transmitter to trip due to operation of the overload protection circuits is considerably reduced. Some benefit may result from such an increase in filament voltage where the transmitter has a tendency to trip, from time to time, without any apparent cause.

In any case, it would be as well to check the oscillator valve filament voltage in accordance with the procedure set out in Part 2, Chap. 2, but using an accurate testmeter such as a multimeter Type 1 on the 100V. range, or an accurately calibrated moving iron meter. The filament voltage should only be set to 17V where the stability of the mains voltage can be guaranteed. If there is any doubt about this the filament voltage should not be set higher than 16.5V in order to avoid any possibility

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of the filament voltage rising above the rated maximum of 18V for the valves.

(5) *Arcing in oscillator valves CV.2163.*

All replacement valves Type CV.2163 should have been "aged" prior to being supplied to the RAF. However, when fitting a new valve, it is advisable to run it at slightly below maximum HT for a few hours to avoid any possibility of an internal flashover.

Arcing in old valves is an indication that the oscillator is either feeding in to a mismatch or that the valves are soft and due for changing. A soft valve will be indicated by blue glow within the valve.

(6) *Sparkling at grid and anode rings of valves Type CV.2163.*

The grid and anode rings of these valves are sometimes painted when manufactured and may need cleaning where the contact fingers make on them, when fitting new valves.

RECEIVER

General

10. The procedure for receiver fault-finding is conventional and will not be detailed here. The

following special points should, however, be noted:—

(1) A deterioration of signals or a high noise factor is possibly due to defective valves V1 and V2 in the amplifying unit (RF) Type 299.

(2) Caution must be exercised when changing valves, as normally the receiver should be realigned if valves are changed.

(a) When valves are changed in the RF unit, the tuning of the unit should be checked at the first opportunity.

(b) If a valve fails in the IF unit, the complete unit should be changed. In an emergency V1 in the IF unit could be changed, and possibly V2.

(3) If the receiver should start oscillating, the neutralization should be suspected. Details of the adjustment of this are given in Part 2, Chap. 3.

MISCELLANEOUS

Switch unit (T and R) Type 405

11. If the enclosed spark gap (receiver protector) on the switch unit (T & R) is alight all the time, this is not necessarily indicative of a fault condition, but is probably due to RF pick-up by the switch unit frame.

- (20) Check by means of the dummy load Type 29 that the RF Output is not less than 450kW (A.P.2527D, Vol. 1, Chap. 6, Para. 54).
- (21) Run transmitter down by depressing the OFF button on panel (meter) Type 863. Depress transmitter ON button on control unit (training) Type 618 on rack assembly Type 327 and ensure that the Transmitter runs up normally and the *green* lamp on the control unit Type 618, labelled TRANSMITTER ON lights when FILS ON lamp lights on the transmitter. As soon as the HT UP lamp on the transmitter lights, ensure that the TRANSMITTER UP lamp on the control unit Type 618 also lights.
- (22) Depress transmitter OFF button on the control unit Type 618 and ensure that the transmitter shuts down.

AMPLIFIER TYPE A.3694

4. The bandwidth selector switch should be set to the 1 Mc/s position.

(1) Insert output of signal generator Type CT.53 or Type 68 set to 45 Mc/s into SK16 of amplifier unit Type 301 (part of trigger unit Type 2 in transmitter Type 3705, No. 1). Select transmitter No. 1 on panel control (cap switch) Type 869. Set signal generator attenuator to zero (maximum output). Turn monitor selector switch on the left-hand side of the transmitter to SECOND DETECTOR CURRENT position. Set GAIN control on amplifier Type A.3694 to MAX, and adjust GAIN control on the trigger unit Type 2 to give a reading on the meter to any convenient level between 200 and 300. This reading will be known as the standard reference figure (SRF). Remove output of signal generator from SK16 and insert normal plug. Connect output from signal generator Type CT53 or Type 68 to SK2 on amplifier unit Type A.3694, No. 1. Adjust frequency of signal generator for a maximum deflection of the meter. This reading should be approximately at the station operating frequency. Ensure that the coaxial cable from SK7 of transmitter No. 1 is plugged into SK3 of the amplifier Type A.3694 and that SK4 is terminated by a terminating resistor. Adjust attenuation of the Type CT53 or 68 until the SRF is again produced. The attenuator reading should be $87\text{dB} \pm 6\text{dB}$.

(2) Repeat above tests for the amplifier Type A.3694, No. 2.

Note . . .

Final careful tuning of the amplifying unit (RF) Type 299 should be carried out to obtain maximum response from a non-varying PE when displayed on monitoring unit Type 82 in the transmitter, and then the GAIN control should be set up as in Part 2, Chap. 3, para. 14-15.

(3) Noise tests.

(a) Connect one output of the amplifier to a 68-ohm load (terminating unit Type 34) and the other to the input of the amplifier Type A.3680, via an attenuator Type 113 set to give $12\frac{1}{2}\text{dB}$ attenuation.

(b) Connect a meter (multimeter Type 1 or Type CT38) between the junction of C29 and L16 on the amplifier Type A.3680 and earth. Set the meter to a suitable voltage range.

(c) Set a signal generator Type CT53 to the station operating frequency, using a suitable wavemeter.

(d) Inject the output of the signal generator into the RF amplifier, setting the four tuning dials to the correct reading as given by the calibration chart on the amplifier cover.

(e) Tune the four controls on the RF unit to give a maximum detector current.

(f) Substitute the signal generator (noise) Type 1 for the signal generator Type CT53.

(g) Connect a test set 4341 between the attenuator and the input to amplifier Type A.3680.

(h) With the noise generator switched on but with the RANGE switch at OFF, and with the test set 4341 switched to 0 dB, adjust the GAIN control (on the front of amplifier Type A.3680) until the meter has a suitable reading (say, 5V).

(i) Switch the noise generator RANGE switch ON.

(j) Switch the test set 4341 to 3 dB and adjust the noise generator output to give the same meter reading as obtained in operation (h). The reading of the meter on the noise generator gives the receiver noise factor. It should be not greater than 6, which corresponds to 8 dB.

(4) Check all meter readings on the built-in meter. These should be within the limits specified below:—

Switch Position	Reading
1	$9.5 \pm 15\%$ (8.0 to 10.9V)
2	$55 \pm 10\%$ (49.5 to 60.5V)
3	$21 \pm 10\%$ (18.9 to 23.1V)
5	$210 \pm 5.0\%$ (199.5 to 220.5V)

Panel, control (capacity switch), Type 869

Transmitter changeover switch

5. The operation of this switch is covered in the section of this chapter dealing with the transmitter Type 3705, para. 3.

$\frac{1}{4}$ PRF alternator

6. Switch on the DC Mains and the capacity switch motor input. Turn meter switch to position 1, $\frac{1}{4}$ PRF ALT. FIELD. Connect a multimeter Type 1 set to the 100V AC range between tag block 2, pin 12 and earth on the phasing unit Type 30. Adjust the $\frac{1}{4}$ PRF ALT. FIELD control to give a reading on the test meter of 70V. The reading on the built-in meter of the capacity switch control panel should be from 63 to 77V.

7. Connect the multimeter Type 1 set to the 100 volt AC range between tag block 2 on the phasing unit Type 30, pins 9, 10 and 11, in turn, and earth. The reading on the test-meter in each case should be from 63.5 to 73.5V.

Master PRF alternator

8. Turn the meter switch to position 2, MASTER PRF ALT. FIELD. Connect multimeter Type 1, set to the 100 Volt AC Range, between tag block 1, pin 10 and earth on the phasing unit Type 30. Adjust the MASTER PRF ALT. FIELD to give a reading on the built-in meter of 55 volts. The reading on the test meter should be within the limits 66.5 and 77V.

DC mains

9. Turn the meter switch to position 3, DC MAINS. Ensure that the built-in meter reads between 218.5 and 241.5V.

Capacity switch

10. With the transmitter operating under normal conditions, the trigger switch in the trigger unit Type 2 set to the external position, strike a neon from the feeder associated with the TOP array in the capacity switch cubicle. Observe the position of the capacity switch rotor blade from the TOP

aerial stator inspection cover. The position of the blade should be as in Part 1, Sect. 6, Chap. 2, Fig. 2.

11. Change over to the standby waveform generator Type 79 contained in the rack assembly (master trigger) Type 182 and repeat as in para. 10.

Phasing unit (PRF) Type 30

12. Check all meter readings on the built-in meter. These should be within the limits specified below:—

Switch position	Reading
HT+	$2.6 \pm 10\%$
V2	$0.8 \pm 25\%$
V3	$0.8 \pm 25\%$
V4	$0.8 \pm 25\%$
V5	$0.8 \pm 25\%$

AERIAL SYSTEM

13. Details of the tests on the aerial system are given in Chapter 2 of this part, para. 38 to 78.

Chapter 2

RADAR TYPE 7 Mk. 3

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Introduction

1. The information in this chapter is extracted from the relevant GCI station test specifications, and is included here for information. The tests herein are normally carried out as part of overall station testing, and details of these tests will be found in the station test specification which is held on the site.

Test equipment required

2. This schedule does not include 'built-in' test equipment in the transmitter well.

- (1) Oscilloscope Type 13A.
- (2) Signal generator Type CT.53 or TF.801A.
- (3) Wavemeter Type 1649.
- (4) Stop watch.

- (5) Calibrated spirit level.
- (6) Test meter Type D1.
- (7) Test set Type 404.
- (8) Test kit Type 29A.
- (9) 5 ft. by 2 in. by 2 in. plane surface.
- (10) Lines for checking Type 7 framework with brackets.
- (11) Plumb line.
- (12) Insulation resistance tester Type D.
- (13) Multimeter Type 1 (10S/16411) or Avometer Model 8.
- (14) Test set 4341.
- (15) Attenuator unit Type 113.
- (16) Amplifier (IF & VID.) Type A.3680.

(A.L.I.2, Jan. 57)

(3) Noise tests.

- (a) Connect one output of the amplifier to a 68-ohm load (terminating unit Type 34) and the other to the input of the amplifier Type A.3680, via an attenuator Type 113 set to give $12\frac{1}{2}$ dB attenuation.
 - (b) Connect a meter (multimeter Type 1 or multimeter CT38) between the junction of C29 and L16 on the A.3680 and earth. Set the meter to a suitable voltage range.
 - (c) Set a signal generator Type CT53 to the station operating frequency, using a suitable wavemeter.
 - (d) Inject the output of the signal generator into the RF amplifier, setting the four tuning dials to the correct reading as given by the calibration chart on the amplifier cover.
 - (e) Tune the four controls on the RF unit to give maximum detector current.
 - (f) Substitute the signal generator (noise) Type 1 for the signal generator Type CT.53.
 - (g) Connect a test set 4341 between the attenuator and the input to the A.3680.
 - (h) ~~With the noise generator switched on but with the RANGE switch at OFF, and with the test set 4341 switched to 0 dB, adjust the gain control (on the front of the A.3680) until the meter has a suitable reading (for example, 5V.)~~
 - (i) Switch the noise generator RANGE switch ON.
 - (j) Switch the test set 4341 to 3dB and adjust the noise generator output to give the same meter reading as obtained in operation (h). The reading of the meter on the noise generator gives the receiver noise factor. It should be not greater than 6, which corresponds to 8 dB.
- (4) Check all meter readings on the built-in meter. These should be within the limits specified below:—

Switch Position	Reading
1	$9.5 \pm 15\%$
2	$55 \pm 10\%$
3	$21 \pm 10\%$
5	210 ± 5.0

RACK ASSEMBLY (MASTER TRIGGER) TYPE 183

5. Green light should be on, indicating normal operation.

Power unit changeover and meter readings

6. Switch METER SELECTOR switch to switch unit Type 413 to POWER UNIT 1/2 + 300V and check that the meter reads 3.0. Switch off power unit 1 and check that *red* indicator light comes on (power unit failure) and that the meter reading remains at 3.0. Switch ON Power Unit 1, wait until the *red* light goes out, and switch OFF Power Unit 2. Check that *red* light comes ON and that meter reading remains at 3.0. Switch ON power unit 2.

Red light should be extinguished. Switch METER SELECTOR switch on switch unit Type 413 to POWER UNIT 5/6—200V and check that the meter reading is 2.0. Switch OFF power unit 5. Check that the *red* lamp comes on and that the meter reading remains at 2.0. Switch ON power unit 5, wait until the *red* light goes out and switch OFF power unit 6. Check that the *red* light comes on and that the meter reading remains at 2.0. Switch on power unit 6. The *red* light should be extinguished. Changeover the POWER UNIT 5/6 MASTER/STANDBY switch and repeat the above. Switch METER SELECTOR Switch to POWER UNIT 1/2 CURRENT and check that the meter reads 2.85 ± 10 per cent.

Note . . .

Delay units should be switched on when these readings are taken. Switch to POWER UNIT 5/6 CURRENT and check that meter reads 0.3 ± 10 per cent.

Note . . .

If amber light comes ON during the changeover of power units 1 and 2, the re-set button on the switch unit Type 413 should be pressed to ensure that the waveform generator is still working satisfactorily, that is, the amber light goes out.

Waveform generator changeover and meter readings

7. Replace the valve in generator 1. Selector generator 2 on waveform generator SELECTOR SWITCH. Press SET NORMAL button to extinguish *Amber* light. Turn METER SELECTOR SWITCH to VIOA-GEN2, meter should read not less than 1.5. Turn METER SELECTOR Switch to VIOB-GEN2, Meter should read not less than 1.5. Remove CV.2127 over monitor Point X7 on waveform generator No. 2. *Amber* light should come ON and pulse displayed on monitor should re-appear in less than 10 seconds, indicating satisfactory changeover of waveform generators. Replace valve on generator 2. Switch OFF 250 c/s on switch unit Type 413. *Amber* light should come ON indicating sync. failure.

Delay unit Type 31

8. Remove plug from output socket SK3, and insert a 68 ohms terminating unit. With oscilloscope Type 13A synchronized from test pulse output, obtained from socket at bottom (rear of rack) monitor delay output at point x2. The pulse observed should be 4 microsecs. ± 0.5 microsecs. wide and 20 ± 3 volts in amplitude. To test bottom delay unit (TEST DELAY) use sync. from x2 on top delay unit to synchronize oscilloscope and adjust delay on BOTTOM DELAY to its original setting.

Note . . .

The fact that the delays of the various pulses are correctly set will be tested by satisfactory operation of the displays, etc.

Plug wander jack plug from panel (meter) Type 650 into jack on delay unit and check that reading is 1.8 ± 0.2 .

Transformer unit Type 4278

9. The performance of this unit is proved by the satisfactory operation of the amplifier unit Type 4279 in the radar office.

RACK ASSEMBLY (INFORMATION GENERATOR) TYPE 318**Amplifier (servo) Type 297, control unit Type 600, rectifier unit Type 17**

10. These units are tested as part of the turning gear.

Amplifier (IFF) Type A.3677

11. Check that all meter readings on the built-in meter are within the limits listed below with SK2, SK4 and SK6 terminated in 220 ohms.

*Switch**Position**Reading*

V2	0 to 0.6 as RV4 is varied	The readings need not reach these limits, but they should not exceed them
V3	0 to 0.5 as RV4 is varied	
V4	2.7 ± 15 per cent.	
V6	0 to 0.6 as RV5 is varied	
V7	0 to 0.5 as RV5 is varied	
V8	2.7 ± 15 per cent.	
V10	0 to 0.6 as RV6 is varied	
V11	0 to 0.5 as RV6 is varied	
V12	2.7 ± 15 per cent.	
HT+1	2.45 ± 10 per cent.	

12. Using the oscilloscope Type 13A, monitor the input to the amplifier (Channel 1) at monitor point x1. Adjust the Receiver "Gain" control to give noise level of 5 volts. Now monitor amplifier output at monitor point x3. As the BIAS 1 Control is rotated from the fully counter-clockwise position a stage should be reached where both the signal and the noise output are of the full "sliced" amplitude. Continue rotating the control clockwise until only occasional peaks of noise are seen. This is the final setting.

Amplifier Type A.3719

13. Connect the output of a signal generator Type CT.53 or TF.801A to SK2 on an amplifier Type A.3694. Remove output plugs SK3 and SK4. Connect a test set 4341 to SK3 and a multimeter Type 1 (Avometer Model 8) set to the $50\mu\text{A}$ range, to SK2 of the test set. Terminate SK4 with a terminating unit Type 34. Set the frequency of the signal generator to the station frequency CW and tune up the amplifying unit Type 299 to give maximum reading on the multimeter Type 1, adjusting for convenient levels during tuning by means of the signal generator output attenuator.

14. Disconnect the test set and connect lead from the amplifier Type A.3719 to SK3 on the receiver. Adjust the output attenuator on the signal generator to give a convenient reading on the built-in IF output meter in the amplifier Type A.3719. Check that the amplifier Type A.3719 is tuned to give maximum reading on the meter, by varying frequency of signal generator about the correct frequency.

15. Connect the output of the signal generator Type CT.53 or TF.801A by means of a double-ended coaxial connector to PL4 on amplifier unit Type A.3719. Set output attenuator on the signal

generator to 0 dB. Set frequency of the signal generator to 45 Mc/s. The figure obtained on the IF output meter will be known as the **Standard Reference Figure (SRF)**. Disconnect signal generator output from PL4 and reconnect to SK1 on the amplifying unit Type 512 contained in the amplifier Type A.3719. Reconnect PL4 to SK3 on the amplifying unit Type 512. Adjust frequency to obtain maximum reading on the IF output meter. Decrease output of signal generator until the SRF is again obtained. Attenuator reading should not be less than 26 dB.

16. Set output attenuator of the signal generator to 26 dB. Note IF output meter reading. Increase output of the signal generator by 3 dB. Increase frequency of signal generator until the above reading is again obtained. Note this frequency (f_1). Now decrease frequency until the reading is obtained again. Note this frequency f_2 . The bandwidth ($f_1 - f_2$) should be not less than 1.5 Mc/s. Reset the signal generator to the tuned frequency of the amplifier Type A.3719.

17. Set the output attenuator on the signal generator to 19 dB. Note the IF output meter reading. Disconnect the signal generator and restore all connections to normal. The IF output meter reading due to noise should not exceed the reading as obtained above, that is, for 19 dB input from signal generator.

Transformer unit (selsyn) Type 175

18. The satisfactory operation of this unit is proved in the overall station tests specified in the station test specification.

RACK ASSEMBLY (CONTROL) TYPE 330**Control unit (training) Type 618**

19. Ensure that the switches on the power board in the transmitter well associated with the Ward-Leonard system are ON. Depress button labelled START and ensure that the motor generator set starts up. Ensure that by depressing the button labelled STOP, the motor generator set runs down.

20. Turn aerial safety switch to OFF. Depress START button on control unit Type 618. Depress RAISE button for approximately 10 seconds only. Ensure that the rheostat, positioned next to the motor generator set, turns clockwise. At releasing the RAISE button, ensure that the rheostat arm returns to its fully counter-clockwise position automatically. During these tests, the aerial framework should be stationary.

21. Turn aerial safety switch to ON. Depress RAISE button. Keep button depressed until the RPM meter reads 3.0 ± 0.1 . Check by means of a stop watch that the rotational speed of the aerial framework is 6 RPM. This test should not be carried out under conditions of high wind, that is to say, one greater than about 40 knots.

22. Depress LOWER button and ensure that the meter readings decrease reasonably steadily to ZERO.

(A.L.12, Jan. 57)

23. Transmitter ON and OFF controls have been tested in para. 3 (21) and (22) of this chapter.

Panel meter (PRF) Type 871

24. Display 250 c/s obtained from GPO tag block on Y1 plate of an oscilloscope Type 13A. Switch VELOCITY RANGE of oscilloscope to X1. Connect internal 50 c/s Cal. to the X plate of the oscilloscope.

25. Turn the Adjust Cap. switch Alternator Frequency Control until a Lissajous figure of 5:1 is obtained.

26. Switch meter switch to CHECK CURRENT and ensure that the reading is 50.

27. Switch meter switch to FREQUENCY and ensure that the reading is 50 ± 2 .

Control unit (training) Type 620

28. The turning gear controls, are checked as part of the turning gear.

Synchronization to Type 7 (rotational)

29. With the Type 7 aerial rotating at 6 RPM. clockwise and the function selector on control unit Type 620 set to POSITION CONTROL, close the SYNC switch on this unit. (After turning gear services to the radar Type 79 shall be in operation). After a short period the meter on control unit Type 620 should settle to a steady reading. Switch the function selector to CONTINUOUS ROTATION. The reading on the meter should drop to approximately zero. Depress button on control unit Type 620. The meter reading, which will fluctuate as the aerials rotate, should not exceed 2, which corresponds to a lag of 2 degrees.

MISCELLANEOUS EQUIPMENT

Panel control (capacity switch) Type 869

Transmitter changeover switch

30. The operation of this switch is covered in the section of this chapter dealing with the transmitter Type 3705, para. 3.

$\frac{1}{4}$ PRF alternator

31. Switch on the DC mains and the capacity switch motor input. Turn meter switch to position 1, $\frac{1}{4}$ PRF ALT. FIELD. Connect a test meter Type D1 set to the 120V AC range, between tag block 2, pin 12 and earth on the phasing unit Type 100. Adjust the $\frac{1}{4}$ PRF ALT. FIELD control to give a reading on the testmeter of 70 volts. The reading on the built-in meter of the panel control switch should be $70 \text{ volts} \pm 10\%$ (63-77V.)

32. Connect the test meter Type D1 set to the 120V. AC range between tag block 2 on the phasing unit Type 100, pins 9, 10 and 11 in turn and earth. The reading on the testmeter in each case should be $70 \text{V} \pm 5\%$ (66.5-73.5V.)

MASTER PRF alternator

33. Turn the meter switch to position 2. MASTER PRF ALT. FIELD. Connect a test meter Type D1, set to the 120 Volt AC range, between tag block 1, pin 10 and earth on the phasing unit Type 100.

Adjust the MASTER PRF ALT. FIELD to give a reading on the built-in meter of the panel of $55 \text{ volts} \pm 10\%$. The reading on the test meter should, in each instance, be $70 \text{V} - 5\% \pm 10\%$.

DC mains

34. Turn the meter switch to position 3, DC MAINS. Ensure that the built-in meter reads $230 \text{V} \pm 5\%$.

Capacity switch

35. With the transmitter operating under normal conditions, the trigger switch in the trigger unit Type 2 set to the external position, strike a neon from the feeder associated with the TOP array in the capacity switch cubicle. Observe the position of the capacity switch rotor blade from the TOP aerial stator inspection cover. The position of the rotor blade should be as in Part 1, Sect. 6, Chap. 2, Fig. 2.

36. Change over to the standby waveform generator Type 79 contained in the rack assembly (master trigger) Type 183. Repeat para. 35.

Phasing unit (PRF) Type 100

37. Check all meter readings on the built-in meter. These should be within the limits specified below:—

Switch Position	Reading
HF+	$2.6 \pm 10\%$
V2	$0.8 \pm 25\%$
V3	$0.8 \pm 25\%$
V4	$0.8 \pm 25\%$
V5	$0.8 \pm 25\%$

AERIAL SYSTEM

Mechanical checks

Array dimensional checks

38. Drawing dimensions and general geometrical dispositions referred to below should be considered in conjunction with the relevant Drawing LR/D.7088, attached to the station specification.

39. Check that all lines of dipoles are horizontal as follows:—Lay a plane surface of at least four feet in length on the top and between each of the dipole insulators. Starting from the centre of the array and working towards each extreme of the reflector in turn, check that when a spirit level is placed on the top of the plane surface, the bubble always appears in the middle of the scale.

40. The positioning of the dipole assemblies on the frame assembly should be checked.

Note . . .

Spacing measurements should be checked at centre of array. Deviations due to "sag" of screen should be disregarded.

Distance from centre-line of lowest dipole of TOP array to upper dipole of MIDDLE array = 7 ft. $7\frac{11}{16}$ in.

Distance from centre-line of lower dipole of MIDDLE array to upper dipole of BOTTOM array = 2 ft. $6\frac{3}{4}$ in.

Distance from centre-line of lower dipole of BOTTOM array to bottom of frame = 1 ft. $3\frac{1}{2}$ in.

41. Check that the distance between the centres of all stacks is 6 ft. $\pm \frac{1}{8}$ in.

Feeder dimensional checks

42. The specification on the feeder system given below should be considered in conjunction with station specification drawings LR/C.5140 and LR/D.7088.

43. Check that the feeder connection from the cubicle to the BOTTOM array is connected to the mid-point of the horizontal feeder. The accuracy of this setting should be within limits of reading of a steel rule and should not exceed $\pm \frac{1}{8}$ in.

44. Repeat para. 43 for the MIDDLE array.

45. Repeat para. 43 for the TOP array.

46. With the mid-point of the horizontal established as a reference point, check that the inner and outer bay feed points are a distance of 5 ft. 9 in. and 17 ft. 10 $\frac{3}{4}$ in. respectively.

Overall arrangement check

47. The array should be checked to ensure that it conforms with the following drawings:



These drawings will be found with the station specification.

Electrical checks

48. Check that with transmitter running normally no arcing takes place anywhere on the array, or feeder system.

Bottom array—voltage distribution

49. Apply the output from the test set 404 set at crystal position to the main vertical feeder in the transmitter well, set the capacity switch to the appropriate position for feeding the BOTTOM array. Check the distribution of the feeder to the array by applying the standing-wave indicator to the bottom of the vertical feeders to the relevant dipoles, that is, on the front of the screen. The readings taken on the standing-wave indicator are to be converted by reference to the standing-wave indicator calibration curve, to true values. Details of the method of calibrating the standing-wave indicator are given in para. 69. The following ratios of true values should be obtained:—

Bay A		Bay B		Bay C		Bay D	
A ₁	A ₂	B ₁	B ₂	C ₁	C ₂	D ₁	D ₂
A ₂ /A ₁	or	A ₁ /A ₂	=	1	—10%		
B ₂ /B ₁	or	B ₁ /B ₂	=	1	—10%		
C ₂ /C ₁	or	C ₁ /C ₂	=	1	—10%		
D ₂ /D ₁	or	D ₁ /D ₂	=	1	—10%		
D ₁ +D ₂	or	A ₁ +A ₂	=	1	—10%		
A ₁ +A ₂		D ₁ +D ₂					
C ₁ +C ₂	or	B ₁ +B ₂	=	1	—10%		
B ₁ +B ₂		C ₁ +C ₂					

In each instance the ratio should be that of the lower figure divided by the higher figure.

Note . . .

Bay A is the extreme left-hand one, when the observer is facing the front of the array.

Middle array—voltage distribution

50. Repeat as for para. 49 but set the capacity switch to the appropriate position for feeding the MIDDLE array.

Top array—voltage distribution

51. Repeat as for para. 49 but set the capacity switch to the appropriate position for feeding the TOP array.

Standing-wave ratio checks

52. Apply the output from the test set Type 404 to the main vertical feeder in the transmitter well. Set the capacity switch to the appropriate position for feeding the BOTTOM array and check that the following ratios of readings as observed on the standing-wave indicator are obtained for the positions of test as given below:—

- (1) On the horizontal feeders between inner and outer bays:—(that is, A & D) Ratio should not exceed 1·2.
- (2) On the horizontal feeder between its centre point and the inner bays (that is, B or C) Ratio should not exceed 1·2.

Note . . .

Due to the proximity of the column and vertical feeders, this test is difficult to perform. Care should be taken that the standing-wave indicator be held at the appropriate acute angle which should be maintained as nearly as possible the same for the B and C observations.

- (3) On the external vertical feeder:—ratio should not exceed 1·1.

53. Repeat as in para. 52, with the capacity switch set to the appropriate position for feeding the MIDDLE array.

54. Repeat as in para. 52, with the capacity switch set to the appropriate position for feeding the TOP array.

55. Check that the ratio of the readings of the standing-wave indicator on the main vertical feeder inside the transmitter well does not exceed 1·5 with the capacity switch set to each aerial position in turn.

56. Check, as follows, that all aerials are fed exactly in phase by ensuring that the feeders from the transmitter to each of the feed points on the horizontal aerial feeders differ by multiples of one wave length.

Note . . .

This has already been checked approximately by the dimensional checks.

Apply a shorting bar to each of the three centre feed points in the horizontal feeders. Then, with

the capacity switch set to feed the BOTTOM aerial, use the standing-wave indicator to find a minimum reading on the vertical feeder in the transmitter well. Mark this point. Re-adjust the capacity switch to feed MIDDLE and TOP aerials in turn and determine the positions of the two corresponding minima on the vertical feeder in the well. The three points thus obtained should lie within a range of $\pm \frac{1}{4}$ inch, that is, $\frac{1}{2}$ inch overall.

57. Check the breakthrough between the elements of the array by applying the test set Type 404 to the main vertical feeders. Set the capacity switch to the position corresponding to the BOTTOM aerial and apply the standing-wave indicator to the vertical feeders of the TOP, MIDDLE and BOTTOM arrays respectively. The reading on the MIDDLE and TOP arrays should not exceed 2% of that on the BOTTOM array.

58. Repeat as in para. 57 with the capacity switch set to the MIDDLE array. Readings on the TOP and BOTTOM arrays should not exceed 2% of that on the MIDDLE array.

59. Repeat as in para. 57 with the capacity switch set to the TOP array. Readings on the BOTTOM and MIDDLE arrays should not exceed 2% of that on the TOP array.

60. Repeat as in para. 57 with the capacity switch set to feed the MIDDLE plus BOTTOM arrays. Readings on the TOP array should not exceed 2% of the sum of the readings on the MIDDLE and BOTTOM arrays, and the ratio of the readings on the MIDDLE and BOTTOM arrays should be $1 \pm 20\%$.

Test on capacity coupling

61. The paragraphs and tests enumerated in the preceding sections are sufficient to establish the correct functioning of the capacity switch cubicle as a whole. It is not possible to take any readings by application of the standing-wave indicator to feeders contained within the capacity switch cubicle nor will correct values be obtained in any of the checks already given if personnel are present in the capacity switch cubicle during the test. The door must be shut. In order to test the correct functioning of the aerial coupling Type 4197, the test set Type 404 should be connected to the vertical feeder in the transmitter well and capacity switch rotated as in normal operation. The standing-wave indicator should be applied to the vertical feeder in the transmitter well and the standing-wave readings observed when the aerial is locked and when it is held in the three positions opposite and at right-angles to the locked positions. The ratio of the readings should not exceed 1.5 for any of the four orientations.

Power transfer checks

62. Set the capacity switch blade to the appropriate position to feed the TOP array. Ensure that the power transfer (true) from the vertical feeder in the transmitter well to the outside main vertical feeder to the top array is not less than 75 per cent.

63. Repeat para. 62, setting the capacity switch to the appropriate position to feed the MIDDLE arrays.

64. Repeat para. 62, setting the capacity switch to the appropriate position to feed the BOTTOM array.

Horizontal polar diagrams

65. The aerial response should be checked with the aid of an IFF receiver Type ZC.8931, modified to read second detector current and using a steady CW signal from the test set Type 404 feeding a Yagi aerial. The test set should be sited not less than 400 yards distant from the array and the aerial should be clearly visible from the BOTTOM array and the receiver gain set to give full scale reading of second detector current when the aerial is turned to give maximum signal. The aerial should then be disconnected from the test receiver and, without alteration of gain control, the second detector current again noted. This reading is the no-signal reading due to receiver noise and should be subtracted from the signal readings obtained, as herein, in assessing aerial performance or plotting polar diagrams.

The aerial should then be slowly oriented from maximum signal position in steps of 1 degree up to 20 degrees, then in 2 degree steps up to 90 degrees, on either side of maximum signal position. Meter readings should be noted for each direction of the aerial. The meter reading will swing up and down as the signal from the test set is received on side lobes of the aerial polar diagram. The maximum readings obtained on the first side lobes should be not less than 14 dB. below the maximum reading noted on the main beam.

Note . . .

To convert the meter readings obtained from the test receiver to dB, the output of the signal generator Type TF.801A should be fed into the test receiver after the readings have been taken, and a graph plotted. The attenuation necessary to produce the difference in meter reading between main and first side lobes should be noted.

66. Repeat para. 65 with the capacity switch set to the MIDDLE array.

67. Repeat para. 65 with the capacity switch set to the TOP array.

68. On some sites it may be found that the first lobe is not the largest—this is due to obstructions and in no way reflects on the efficiency of the array.

Method of calibrating standing-wave indicator

69. Plot Sine Ø curve A as shown in fig. 1. Sine tables should be used, and points plotted every 5 degrees.

70. Strain out a 1-inch spaced feeder line, as shown in fig. 2. Connect a test set Type 404 to line. Place a short-circuit at some convenient point along the line.

71. Ensure that the test set is set to the operational frequency. With the standing-wave indicator, carefully locate a voltage minimum near the centre of the line. Carefully note and mark the exact minimum position. From that position measure accurately $\lambda/4$ along the line, that is, 14.58 inches. Check that a voltage maxima occurs at that position. Carefully mark this position.

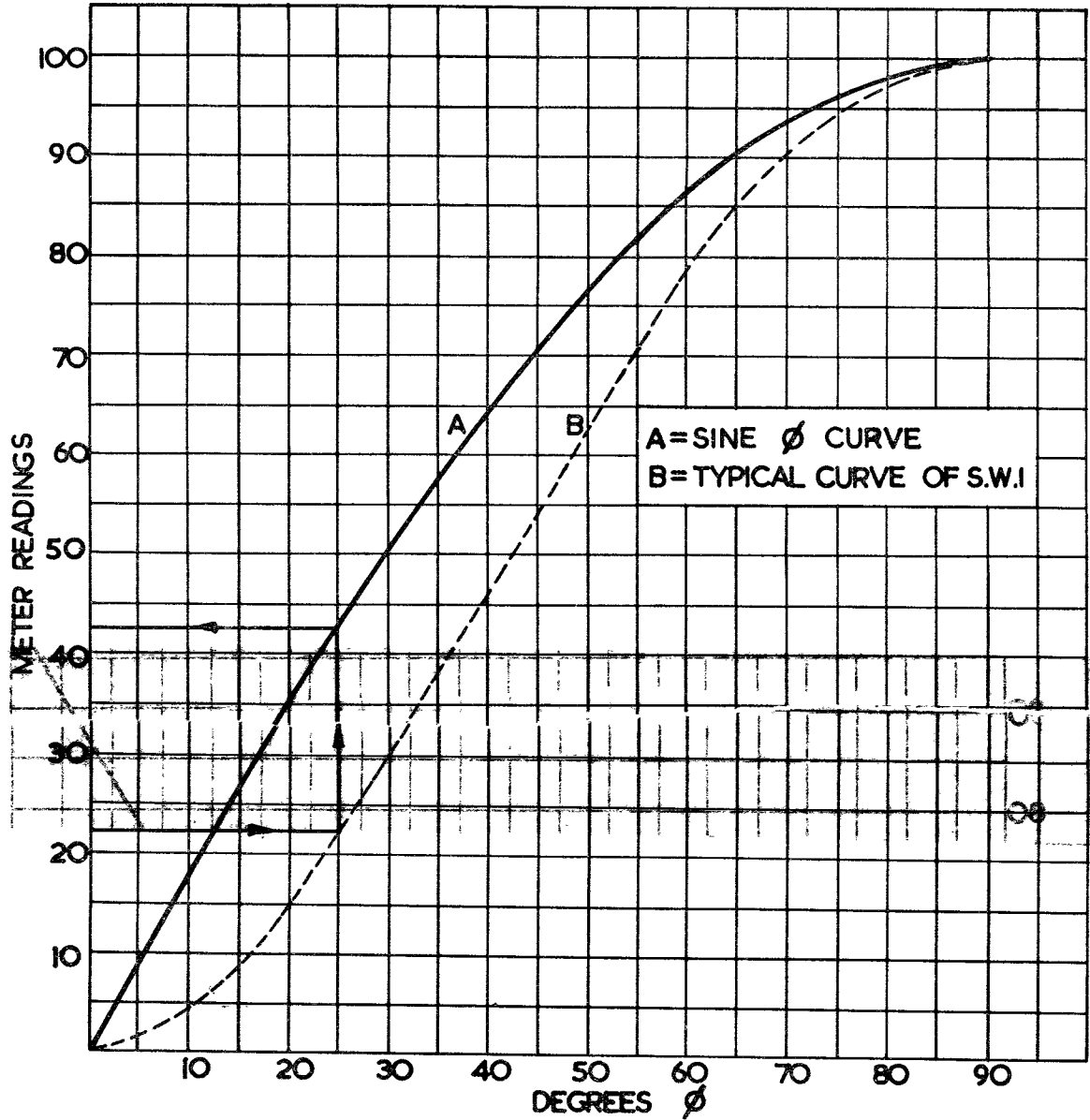


Fig. 1. Standing-wave indicator—calibration procedure

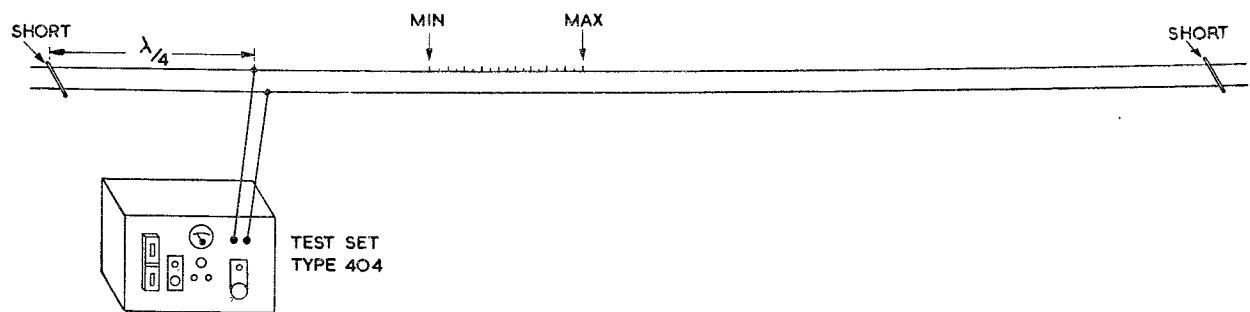


Fig. 2. Standing-wave indicator—calibrating method

Carefully sub-divide the $\lambda/4$ length of line into 18 divisions of .81 in. separation, that is, at every 5 degrees along its length.

72. Place the standing-wave indicator on the line at the voltage maxima position and adjust the output of the oscillator until the standing-wave indicator meter reads exactly $100\mu A$, that is, full scale deflection.

Note . . .

It is important when taking readings to hold the standing-wave indicator at right angles to the line.

This position should be maintained for every reading.

73. Take readings at every 5 deg. commencing at the voltage minima position. Note down these readings, and plot the curve of the readings just taken. A typical curve is shown at B on fig. 1.

74. From the two curves now plotted, that is, curves A and B the calibration curve of the standing-wave indicator can now be plotted. A typical curve is shown on fig. 3, and was plotted from the

two curves shown at A and B on fig. 1. The procedure is as follows:—For every five meter divisions, read across to curve B. From that point, read in a vertical direction to curve A. From that point read across to the meter reading scale. Note the reading at that point. This is the true value. The example shown on fig. 1 is as follows:—Meter reading 22.5. Across to curve B, up to curve A, back to meter reading scale shows true value 42.5.

From the readings obtained, plot calibration curve for the standing-wave indicator. The vertical scale shows meter reading and the horizontal scale shows true values.

Use of the calibration curve

75. The calibration curve is used to convert SWI readings to "true reading" and using the curve shown on fig. 3; a typical example is as follows:—If SWI reading of 65–72 is obtained, then the true values will be 78–82.5 and the true ratio will be $\frac{82.5}{78.0} = 1.0577$.

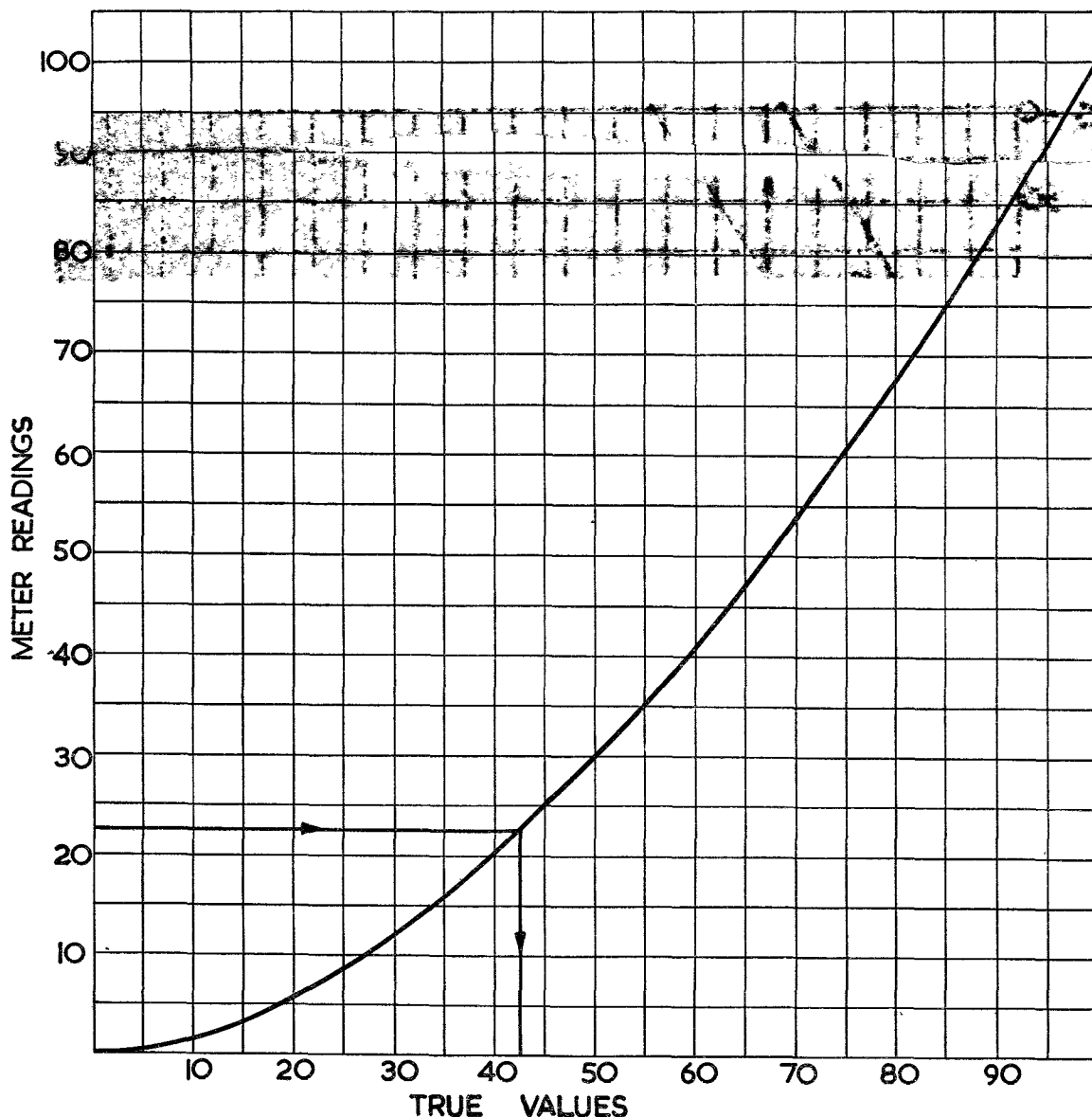


Fig. 3. Standing-wave indicator—calibration curve